PRODUCT ENGINEERING

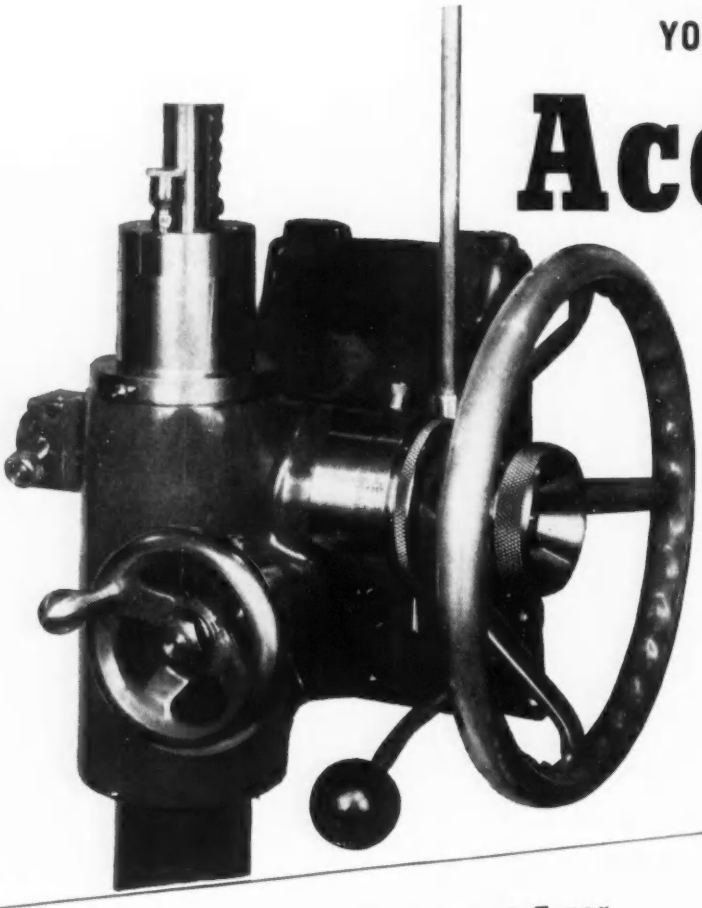
FEBRUARY, 1945

In this Issue: Characteristics of Thermal Resistors

HOW NICKEL HELPS **Maintain**

YOUR MACHINE TOOL OPERATING

Accuracy...



Minimize Thermal-Induced Error by Use of Low Expansion Alloy

SECURE INCREASED PRODUCTION

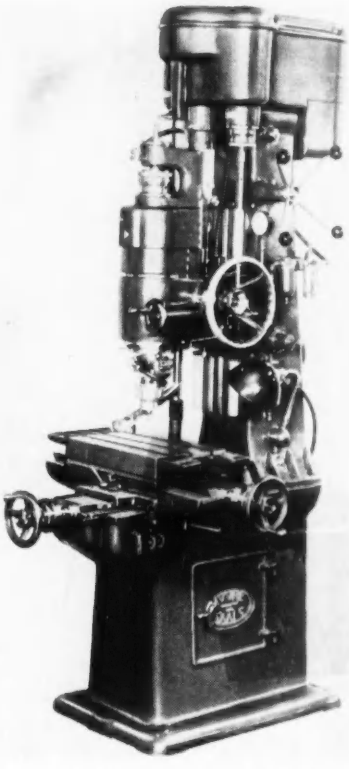
Competitive conditions increase the value of units that provide high accuracy and output.

But accuracy and output fall sharply when temperature changes, even though slight, cause troublesome dimensional changes in castings such as spindle housings. For example, in jig borers and grinders, as much as .0003" to .0005" change in spindle location has been caused by expansion and contraction of housings.

Such deviations reduce output . . . imposing need for warm-up before jobs can be set . . . requiring constant readjustment during operations.

Thermal-induced error can be reduced to a negligible minimum . . . with Type 6 Ni-Resist . . . commonly termed "Invar Iron". Castings of this low expansion alloy, containing 36% Nickel, have proved successful even under very wide temperature changes.

We invite consultation on the use of Nickel Cast Irons and other alloys containing Nickel. Send us details of your problems for our recommendations.



Moore Jig Grinder with Spindle Housing of Low Expansion "Ni-Resist".

Here's what J. R. Moore* says about Type 6 Ni-Resist:

"Since we started using 'Invar Iron' . . . we have found that we have been able to virtually eliminate the warming-up periods previously required to make accurate settings or determine accurate locations. The overall efficiency of these two machines is probably increased by at least 20% and no difficulty on this score has since been encountered by users. This is an important factor, particularly in the use of machines intended to work within tolerances of ten-thousands of an inch."

*Production Manager and Secretary of the Moore Special Tool Company, Inc., Bridgeport, Conn.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

PRODUCT ENGINEERING

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IN THIS ISSUE

Cover Picture—Thermistor Welding. Tiny metallic oxide beads, the essential element of Western Electric Thermistors, being electrically welded to two wire leads prior to sealing in a glass bulb.

Characteristics of Thermal Resistors

Metallic oxides when pressed into disks, extruded into rods or formed into tiny metallic beads are characterized by a high negative temperature coefficient of resistance. R. S.

Goodyear describes on page 93 the basic characteristics of these metallic oxides and gives some of their many applications as elements of an electric circuit.

Organizing Materials

Materials whether well known or new can no longer be judged by a few characteristic properties, accepted by engineers in the past. Wartime necessity has developed new criteria and data which must be evaluated so design as well as fabrication of a material can be predicted accurately and not with the use of factors of ignorance. B. C. Boulton, of the Douglas Aircraft Corporation, in an article on page 73, discusses this problem and makes recommendations as to how engineers can organize such knowledge for the future.

Stainless Steels

In the course of the past 15 years, stainless steels have steadily gained in popularity, their fields of application and the number of their types have expanded. Today the various types of stainless steels present a wide range of properties and characteristics to the designer. The special section starting on page 105 describes the different stainless steels, highlighting the outstanding qualities, applications and methods of fabrication for each type, to help the engineer combine economy with the best use of the chemical and physical characteristics of this series of steels.

Stop Mechanisms

Damage to automatic machines or to work being processed by these machines can be prevented by incorporating stop mechanisms in the design. Devices illustrated on pages 130 and 131 show a variety of means and principles than can be used to stop different types of machines automatically or to cause them to skip an operation. Mechanical, electrical or electronic, hydraulic, pneumatic, or combinations of these means are used.

Heavy Stampings

Press forming and drawing of the heavy gages of sheet and plate have proved so valuable to war production that many large and small parts involving multiple press operations and several annealing operations to maintain ductility are in mass production. Others, in thicknesses from ¾ to 3½ in., are formed hot in comparatively small or in large quantities. Design possibilities and illustrations of press formed parts are presented in the article on page 125.

Method for Calculating Flywheel Energy

Broken crankshafts and frames of presses bear forceful and not infrequent testimony to the error of assuming that approximate formulas are good enough for the calculation of energy stored in flywheels. Henri Lewin, chief engineer, Brown-Boggs Foundry & Machine Company, Ltd. see page 86, discusses the sources of error in the use of the conventional formula and then derives exact equations for the moment of inertia and kinetic energy of flywheels.

Packings for Hydraulic Systems

The second of a series of articles by Howard Field, Jr., discussing the design and application of fluid seals or packings, begins on page 100. Many available types of packings, including some of patented construction, are described and the advantages and limitations of each type is set forth.

Welding Defects

Causes for most defects in welding have been found to be preventable. Knowledge of possible defects, their causes and prevention is helpful when welded design is under consideration. Welded fabrication is graded in quality like other fabrication methods. High or low quality, usually commensuate with cost, is shown to depend on whether modern equipment and skilled workmen do the welding, either in the fabricator's or a contractor's shop. Frederick S. Dever, describes common defects and their prevention in an article beginning on page 121.

Spot Welding 24S Aluminum

The effects of spot welding on the strength of aged 24S aluminum alloy were questioned when this material, which owes its increased strength to heat-treatment, was introduced. The question was answered favorably by the results of an investigation by Lockheed Aircraft Corporation, which are presented by M. L. Ochieano of that company in the article beginning on page 90.

Polar Moments of Inertia of Circles

For facilitating calculations of stresses in rotating shafting, flywheel calculations and other computations involving moment of inertia, F. E. Reed, Jr., senior marine engineer, and A. H. Mason, marine engineer, U. S. Maritime Commission, see page 143, present a table of calculated values of the area polar moment of inertia of circles ranging from ⅛ to 100 inches in diameter in intervals of ⅛ inch.

MARCH HIGHLIGHTS

Engineering Department Organization, by James E. Thompson of the Ryan Aeronautical Company. Analysis of engineering functions and their effect on proper organization.

Classification of Formed Sheet Parts, by Lockheed engineers. Covers sheet aluminum forming, giving 23 classes of shapes and related information on design and forming methods.

Double Differential Gear Train, by L. A. Trofimov. Analysis of a variable-speed drive which consists of two mechanical differentials and a standard variable-speed reducer.

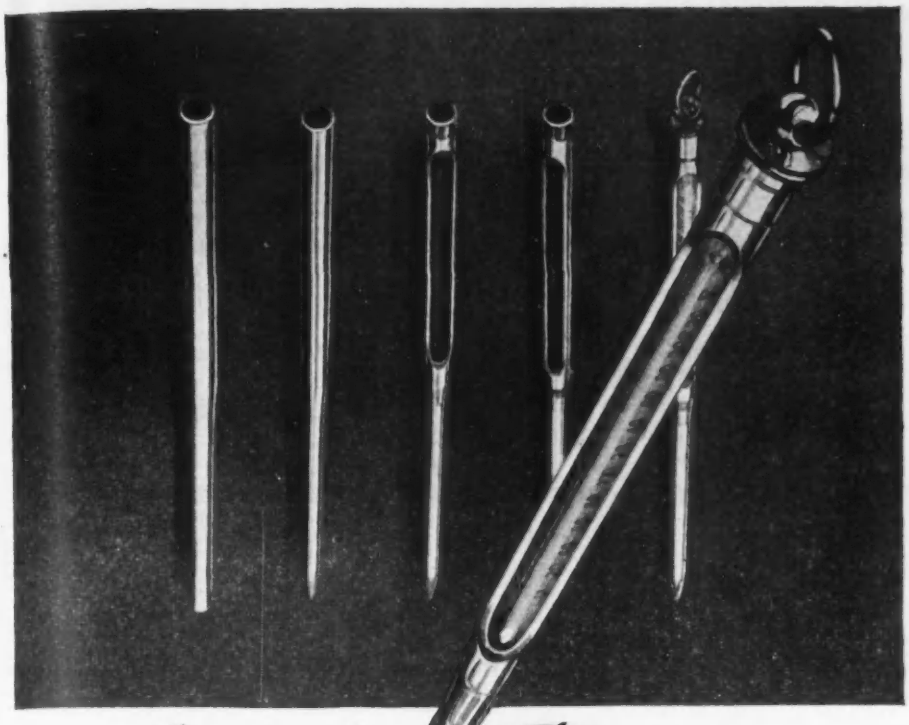
Designing Machine Controls, by H. R. Gogay, Product Engineering Department, The Douglas T. Sterling Company. Suggests that controls be located so that operators can reach them easily to obtain maximum machine efficiency.

Flash Welding, By W. W. Ackerman and Walter Pestrak, Federal Welder. Shows possibilities on SAE 4130 steel, and design and production considerations that assure high quality.

Involute Splines, by Charles Stanard. Advantages obtained by the use of multiple toothed involute splines in concentric mating members of power trains.

Hydraulic Motors and Cylinders, by Howard Field, Jr. Discusses the design of motors and cylinders used in hydraulic systems.

Appearance and Performance of Plastic Parts, by W. S. Larson, Plastics Department, General Electric Company. Discusses factors pertinent to the design of plastic parts for pleasing appearance and satisfactory performance.



The step-tapered pointed tube shown second from left is furnished by Summerill to the manufacturers for machining and finishing into the finished product.

Another Point

ON SUMMERILL TUBING

In the processing of pork, "pig sticker" thermometers are used to check temperatures at the center of the ham. This stainless steel armor was originally made, with threaded joints, from two sizes of tubing and a solid point. The shortcomings of this construction are obvious. Summerill engineers were consulted and they developed means for producing one-piece tubes with swaged reduction and welded tip. The resulting armor is lighter, stronger and lower in cost.

The point we wish to make with you is—there is oftentimes a better way of doing the job—with Summerill engineering counsel plus Summerill Tubing. SUMMERILL TUBING CO., Bridgeport, Montgomery County, Penna.

Write us today for a copy of Bulletin 443 which contains valuable information and data on the many types of Summerill Tubing.

C W S
AFFILIATES

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Pittsburgh, Pa.

EDGAR T.
WARD'S
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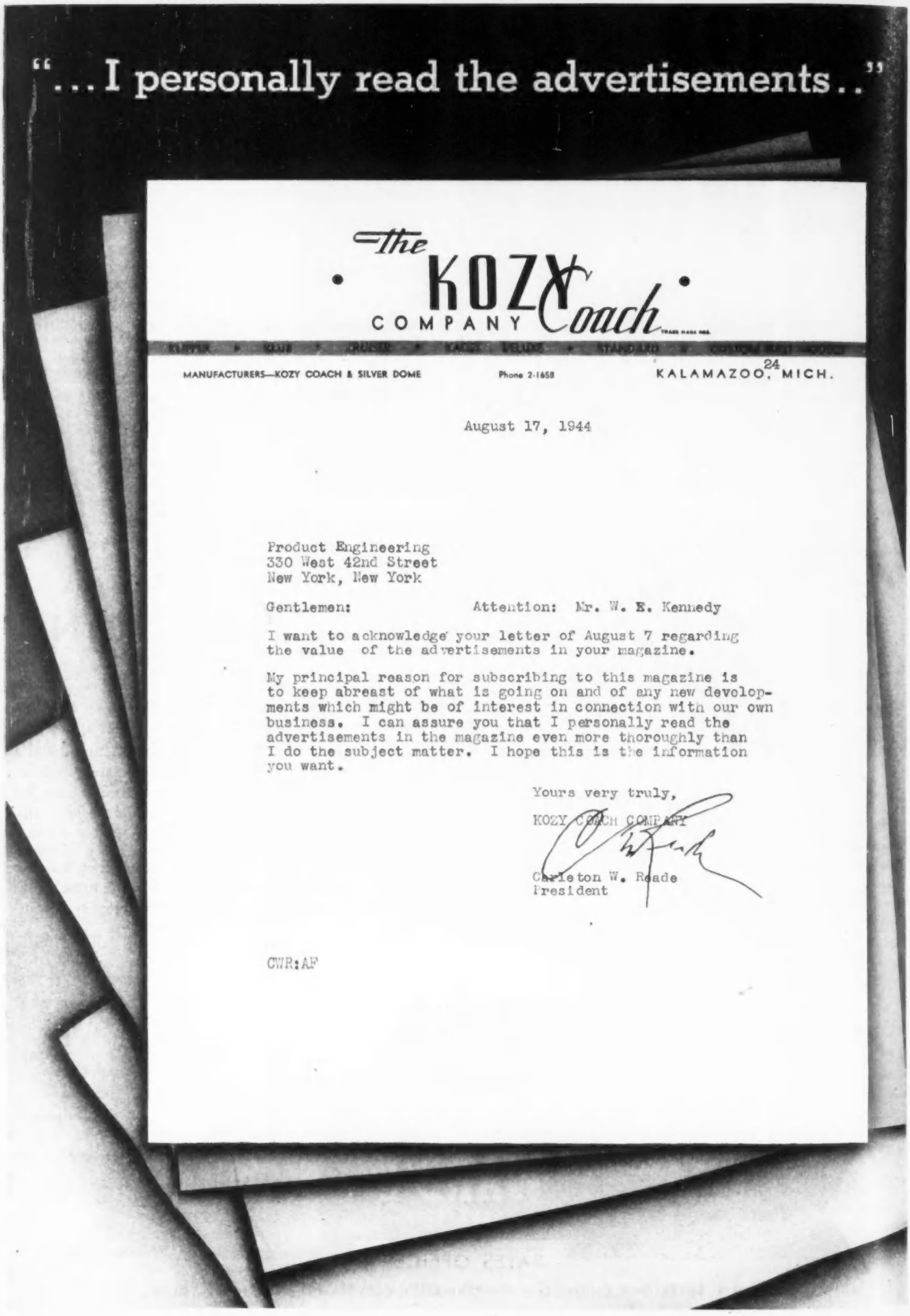
"...I personally read the advertisements.."



The KOZY Coach COMPANY

MANUFACTURERS—KOZY COACH & SILVER DOME Phone 2-1658 KALAMAZOO, 24 MICH.

August 17, 1944

Product Engineering
330 West 42nd Street
New York, New York

Gentlemen: Attention: Mr. W. E. Kennedy

I want to acknowledge your letter of August 7 regarding the value of the advertisements in your magazine.

My principal reason for subscribing to this magazine is to keep abreast of what is going on and of any new developments which might be of interest in connection with our own business. I can assure you that I personally read the advertisements in the magazine even more thoroughly than I do the subject matter. I hope this is the information you want.

Yours very truly,

KOZY COACH COMPANY

Carleton W. Reade
President

CWR:AF

TEST IT AT OUR RISK!

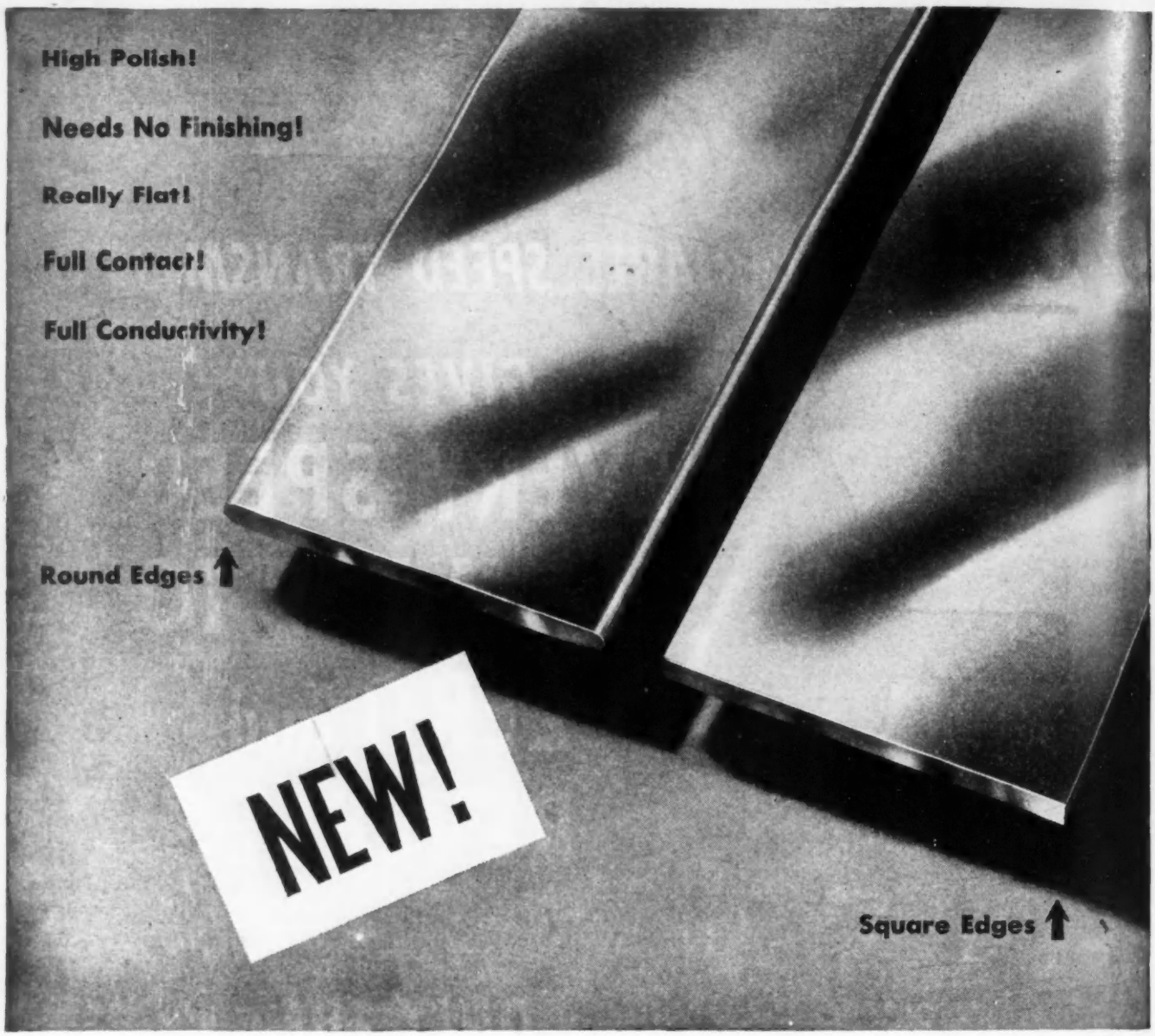
Order the Graham for your laboratory as a utility all-speed test unit. We can deliver. Shown above — Model 60. Input range — 1800 RPM. Output speed range—all speeds, from 300 RPM forward through zero plus shockless reversal to 200 RPM in reverse without stopping the motor. Maximum ¾ H.P.

WRITE FOR BULLETIN 506

OFFERS YOU . . .

1. Unlimited speed range — not just 5 to 1, 10 to 1 or 100 to 1 but every speed to zero, forward and reverse, without stopping the motor.
2. Full torque guaranteed over the entire speed range.
3. Close speed adjustment — guaranteed to hold its speed more closely than any other drive under comparable conditions.
4. New compactness. Combines reduction and range in a single unit. All metal. Self-lubricated. No belts, no tubes. Economical.

GRAHAM TRANSMISSIONS INC., 2706 N. TEUTONIA AVE., MILWAUKEE 6, WIS.



Specially-Prepared Switch Copper by REVERE

Revere has developed a new method of manufacturing Switch Copper to meet the exacting requirements of the electrical industry on an economical basis.

The process produces Switch Copper with a surface finish far superior to regular commercial bar copper, and with exceedingly close tolerances. Flatness measured across the width of the bar is kept to the following Revere standards: — Convexity none. Concavity, .001″ maximum per side up to 2″ wide, .002″ per side, 2″ and over. Camber, or depth of lengthwise arc 1/8″ maximum in 8 feet. Edges are full rounded unless otherwise specified. Made from electrolytic copper, meeting the A.S.T.M. specifications for purity and conductivity.

This is really beautiful metal. Its superior finish and flatness mean that simple cutting and drilling are enough to produce switch blades that will make perfect contact, reducing current losses. Naturally, Revere Specially-Prepared Switch Copper carries a slight premium in price, but those who have used it report this is insignificant compared with the large savings made possible by abandoning the expensive finishing processes required when using ordinary commercial bar. Revere Switch Copper is also being used in: knife-blade fuses; switchboards; in other equipment requiring exposed bus bars. For further information, write Revere Executive Offices.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., New York 17, N. Y.

In war or peace
B.F.Goodrich
FIRST IN RUBBER

1900-foot rubber band snaps iron through a mountain

A typical example of B. F. Goodrich development in rubber

WAR DEMAND for iron ore last year was so great that companies searched out even the "worked over" mines. The one in the picture had some ore — but at the bottom of a pit.

The way to get it out was by conveyor belt, but that would be the highest single lift of any belt in the world and conventional belts that were strong enough would be too stiff to trough and carry heavy ore up the mountain side. So three belts were used, each for a third the distance, but even they wore out fast and transfer points required much attention.

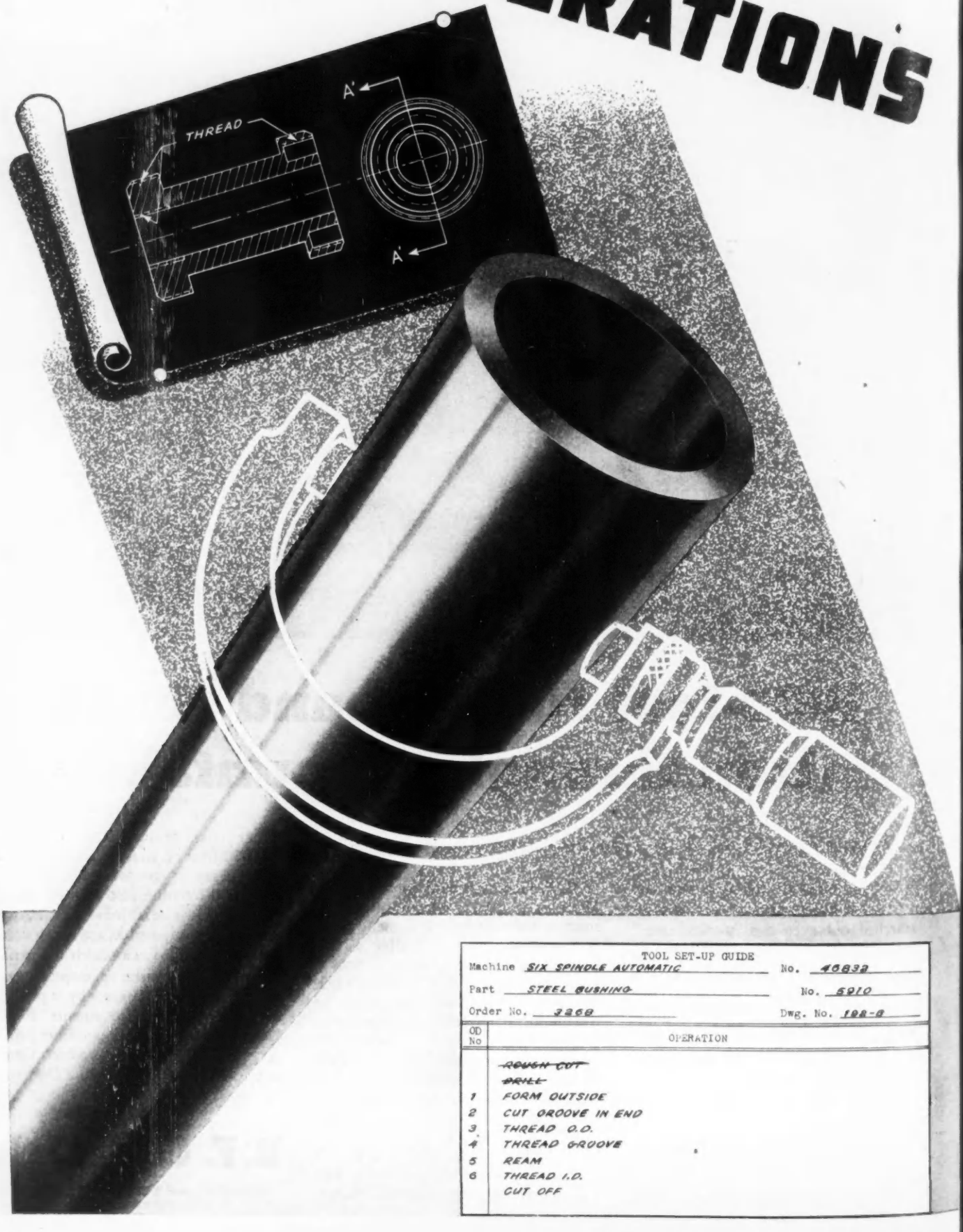
An engineer at this mine had heard of B. F. Goodrich cord conveyor belt. Made of parallel cords in rubber instead of woven fabric, it is many times as strong and still as flexible as any former belt. Extraordinary records made by this new B. F. Goodrich belt on other "impossible" jobs convinced the engineer it would stand the strain on this one.

The belt was installed, at a 35% grade — almost a rubber elevator. The shaft went through the mountain itself, from pit to railroad cars on the surface — a 1000-foot run.

The B. F. Goodrich cord belt "troughed" perfectly, eliminated two transfer points and reduced maintenance cost. It has already hauled 800,000 tons of vital iron ore, and the owners say it is good for at least 1,250,000 tons the first year and thousands more the next. Jobs like this, that have looked impossible, are being done every day by B. F. Goodrich industrial rubber products—the developments of constant research. That's why it pays to find out what improvements B. F. Goodrich has made in any rubber product you use. *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

B.F. Goodrich
RUBBER *and* SYNTHETIC *products*

FEWER OPERATIONS



TOOL SET-UP GUIDE

Machine SIX SPINDLE AUTOMATIC No. 40832

Part STEEL BUSHING No. 5910

Order No. 3268 Dwg. No. 102-B

OD No	OPERATION
	~~ROUGH CUT~~
	~~DRILL~~
1	FORM OUTSIDE
2	CUT GROOVE IN END
3	THREAD O.D.
4	THREAD GROOVE
5	REAM
6	THREAD I.D.
	CUT OFF

LOWER COSTS

for parts machined from ROCKRITE TUBING

Bushings, bearing races and similar parts, can be machined faster and more economically from Rockrite tubing than from bar stock or tubing sized by other methods.

For example, the part shown herewith can be finished on a six-spindle automatic screw-machine, compared with eight or more operations needed when ordinary tubing is used. The close dimensional tolerances of Rockrite tubing permit light, high speed cuts. One-operation form-tool finishing of the outside surface is made possible. The inside can be reamed out and threaded in less time than would ordinarily be required for boring, reaming and threading. This speeding up of the inside operations saves time spent in drilling which slows up screw-machine output. The use of Rockrite Tubing permits synchronization of all the operations for highest production and lowest machining costs.

Manufacturers who are interested in cost-cutting methods for the production of ring shaped or cylindrical parts should investigate this remarkable tubing. Details gladly furnished upon request—and in strictest confidence.

Rockrite Cost-cutting Features

More accurately controlled concentricity of tube bore usually eliminates the necessity of boring. A light cut or fast reaming is the most that is ordinarily required. The outside can be finished with a light cut or by grinding. Often no machining at all is needed. Almost always, machining time is greatly reduced.

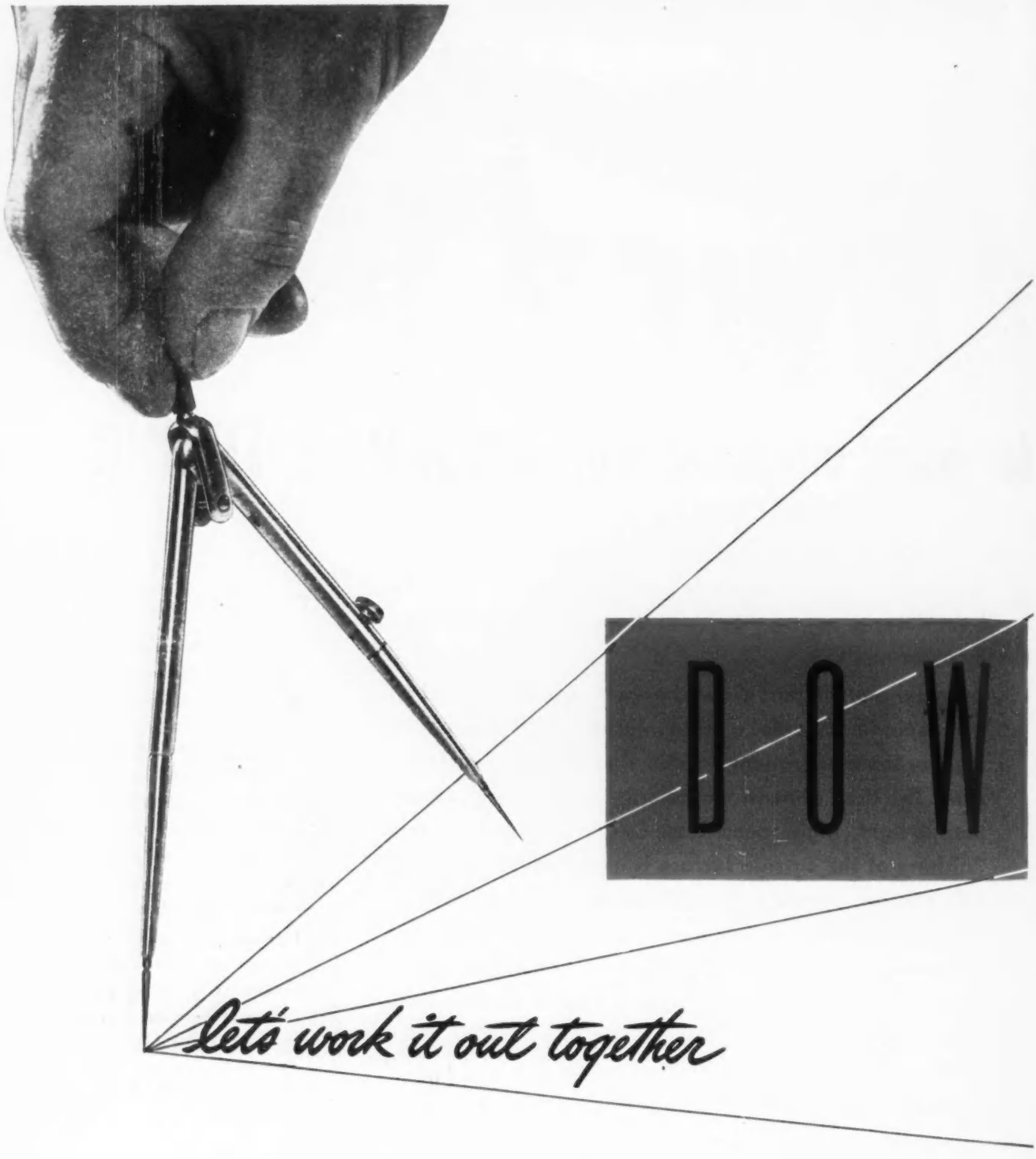
Heavy-wall tubing made to close tolerances by the Rockrite Process.

Improved physicals without costly heat treatment. Rockrite Process is a combination of compression, rolling and extrusion—raises physicals without stressing metal.

Tubes of many analyses of steel and other metals are readily sized by the Rockrite Method. A partial list includes S.A.E. alloys, such as S.A.E. 52100 steel, and stainless steels, beryllium alloys, copper, aluminum and their alloys. Sizes at present are limited to 3⅛" O.D. and smaller.

TUBE REDUCING CORPORATION

WALLINGTON
NEW JERSEY



We at Dow believe that our responsibility to the plastics industry goes beyond the production of new and improved materials. This, of course, is always one of our primary objectives. But the ultimate use of these materials is equally important to us—for plastics are at their best when used properly.

Putting the *right* plastic in the *right* place in the *right* way is not a one-man job, nor even a one-industry job. Rather it calls for that combination of skills found only in manufacturer or designer plus molder plus materials producer. Experience proves that this team, working together, leads directly to success in plastics.

That's why we say "Let's Work It Out Together." And that's why Dow technical advisers are available in all sections of the country to consult with you.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

STYRON

Present and Potential Uses

Lighting fixtures; insulators; battery cases; hydrometers; funnels; bottles; closures; food handling equipment; pharmaceutical, cosmetic and jewelry containers; costume jewelry; novelties; refrigeration parts; pens; pencils; liquor dispensers; escutcheons; floats; chemical apparatus; dishes; lenses; decorative objects, trim.

Advantages and Limitations

Clear, translucent material; broad color range; excellent high frequency electrical insulator; can "pipe" light through rod at angles, around corners, etc.; resistant to acids and many alkalies; low water absorption; light weight; stable at low temperatures. Limited solvent resistance. Available only in rigid forms.

SARAN

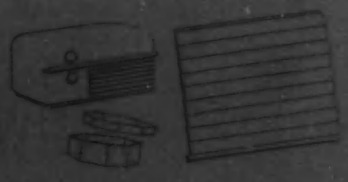
Present and Potential Uses

Plating masks, chemical apparatus, pump parts, valves and valve parts, name plates, meter parts, paint brush handles, insulation, stoppers, funnels, bottles, closures, plumbing parts and equipment, wire coating, etc. Pipe and tubing for chemical apparatus and special installations requiring chemical and corrosion resistance.

Advantages and Limitations

Resistant to chemicals, abrasion, corrosion, water, and moisture; good electrical insulator; excellent thermal insulator; dimensionally stable. Not recommended for installations requiring temperature resistance above 170° Fahrenheit. Tends to brittleness at very low temperatures.

ETHOCEL



Present and Potential Uses

Housings, radio cabinets, aircraft parts, containers, insulators, flashlights, automotive parts, escutcheons, refrigerator parts, tool handles, rods, tubes, bars, and special extruded shapes for kitchen trim, automotive and aircraft window frames, modern window blinds. Also used as tape and wire coating.

PLASTICS

Advantages and Limitations

Extra tough, particularly at low temperatures; attractive colors; pleasant to handle; transparent or translucent; dimensionally stable to varying climatic conditions and temperatures. Light in weight. Available in wide range of flow. Not available in crystal color. Limited chemical and solvent resistance.

DOW PLASTICS EASILY FABRICATED IN THESE FORMS

STYRON (Dow Polystyrene) . . .
For moldings, extrusions, rods, sheets.

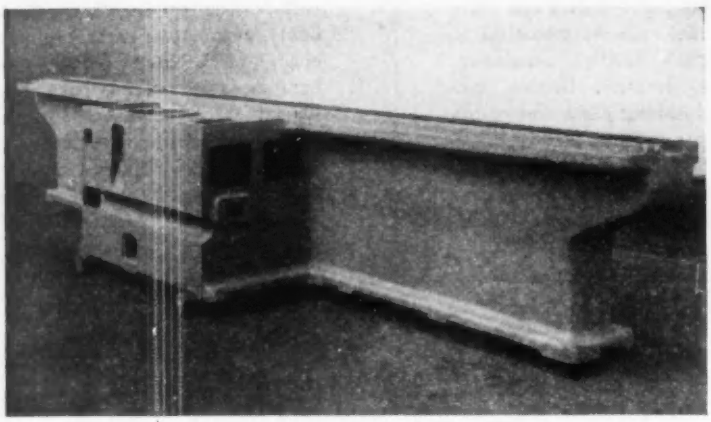
SARAN . . .
For moldings, extrusions, pipe, tubing, sheet, monofilaments; also available as Saran Film.

ETHOCEL (Dow Ethylcellulose) . . .
For moldings, extrusions, coatings; available also as Ethocel Sheeting.

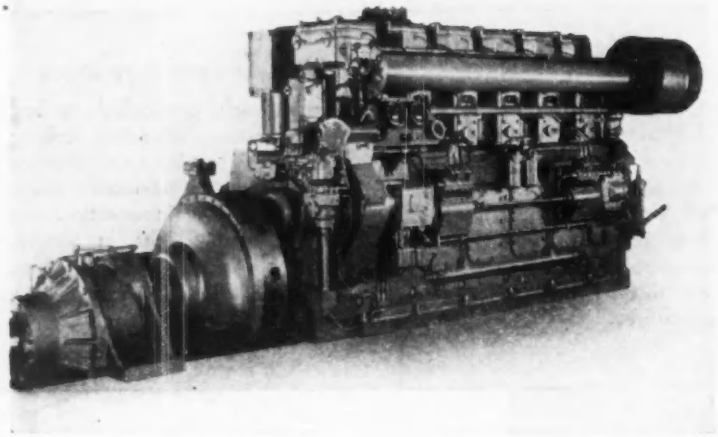
DOW
PLASTICS

Quality Castings Deserve

How a POTENTIAL ASSET becomes in Cooper-Bessemer Meehanite



This high duty iron casting is an 18 foot grinder bed weighing 5600 pounds.



Cooper-Bessemer Type FW marine Diesel engine. Base, frame, and most major parts are Meehanite castings.

Smart appearance has long been recognized as important to the sale of consumer merchandise. It has more recently been emphasized in industrial goods, too.

Here at Cooper-Bessemer we are applying this principle of the "quality look" to our high duty iron castings — not only parts for our own engines and compressors, but our jobbing items as well. Pictured on this spread, unretouched, are a few recent production pieces, ready to ship to customers.

To achieve such appearance, the control of sands and mold facings is under the constant supervision of laboratory technicians. The improved surface finishes thus obtained are protected by applying a prime coat of paint to each casting before it leaves the foundry.

The resultant "quality appearance" has been widely remarked upon and is a recognized aid in the sale of our own and our customers' completed products. And there are these two corollary benefits:

1. Prime painting eliminates rust formation and prevents oil impregnation during machining, assuring a perfect final painting job with the least possible cost and effort.
2. Emphasis on good appearance also means careful, quality workmanship at every step in the foundry operations.

We should be glad to discuss this subject with you further if you are interested.

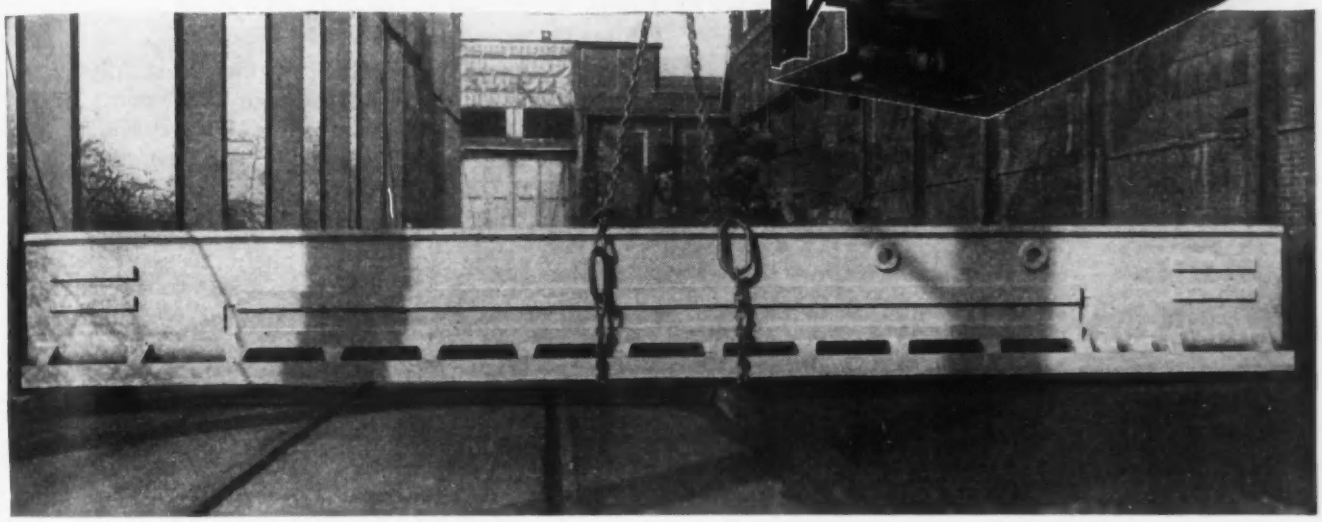
The Cooper-Bessemer
CORPORATION

Quality Appearance

a REAL ASSET

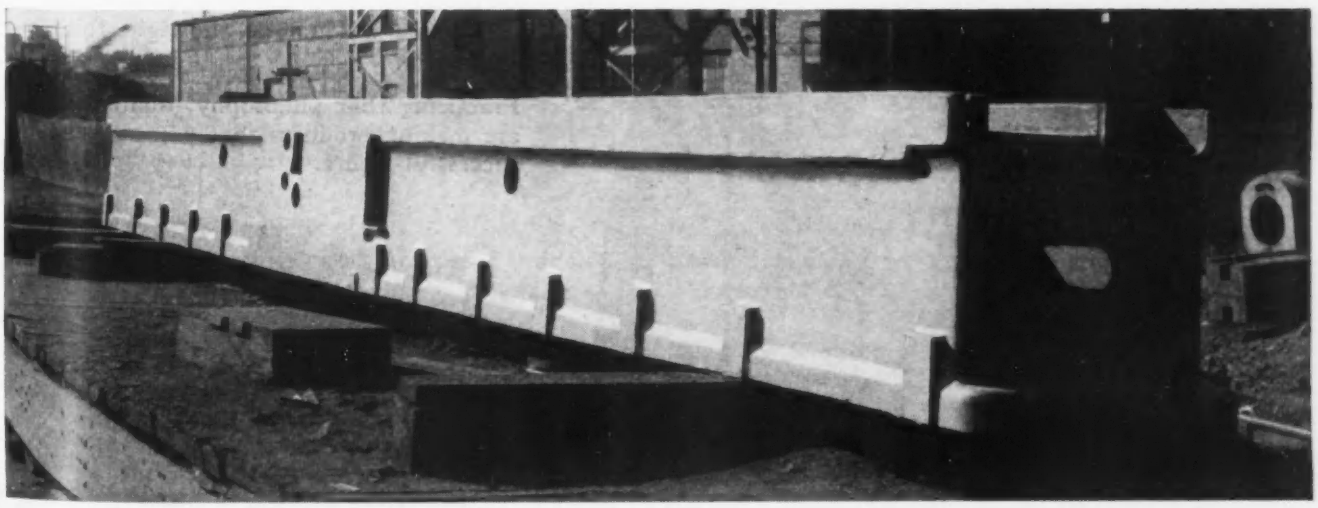
Castings

Centerless grinder bed casting weighing 4500 pounds.



Above: Billeteer roll table, cast of Meehanite Metal is 27 feet long and weighs 22,000 pounds.

Below: This Meehanite casting is a roll grinder bed weighing 18,420 pounds and is 29 feet in length.



Meehanite Foundries

MT. VERNON, OHIO, DEPT. C. GROVE CITY, PENNA. DEPT. F.

then he said to himself

"You're in it for life!"

To those who look at postwar simply as a date on the calendar, the words of Charles F. Kettering, Vice-President, General Motors, add *duration* to that date. Says he:

> "We ought to pay more attention to the future. We ought to pay more attention to it than we do to the past, because every one of us is going to spend the rest of his life in it."

What sort of a life that may be is governed largely by what a man does for his product

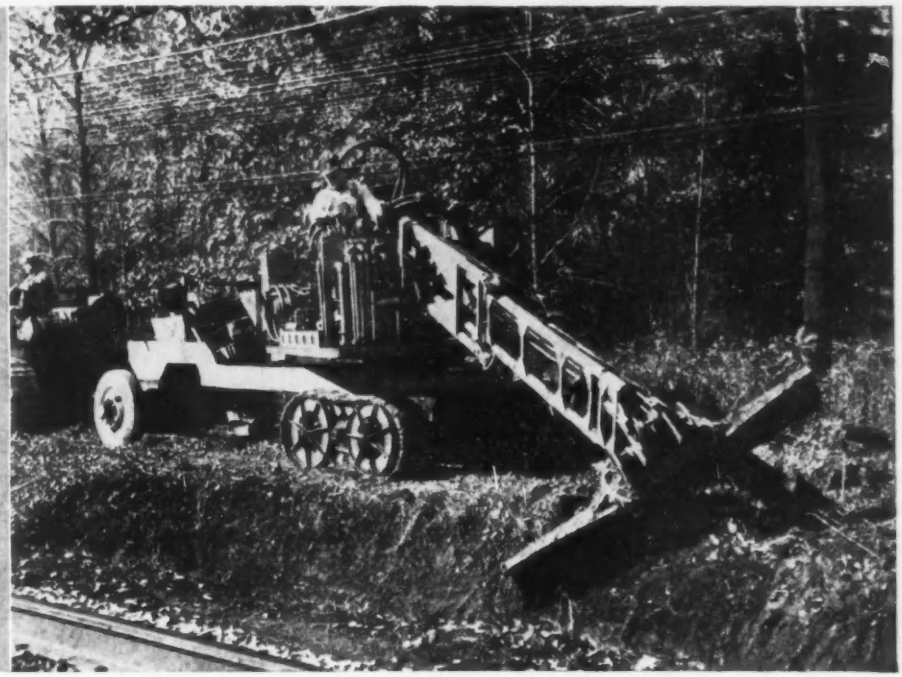
> . . . for it is "Boss" Kettering's contention that he is *not* boss . . . that the machine he is working with is *always the boss*. If he is not doing the right thing for the machine, the machine will not do the right thing for him.

Practicing that philosophy, many men are making products that will assure a successful future.

"Pay Attention to the Future," *he says*

LOOK, MR. KETTERING, how recourse to Arc Welding provides the key to success for ideas in machine design:

MAN WITH AN IDEA STRIKES PAY DIRT WITH WELDED DESIGN



DRAINAGE experience in his homeland Holland and in America taught Ray Ferwerda the need for a machine that would work with the maneuverability of a man with a rake, with his earth-moving power multiplied many thousand-fold.

Thinking in terms of *welded design,* Mr. Ferwerda developed such a machine and improved it until today it is unique in the field of finish-grading equipment.

This man is now president of the F. W. F. Corp., Cleveland, Ohio, manufacturers of the "Gradall" shown above. This machine does many jobs such as the finishing of highway slopes and ditches at about 1/10 the cost of manual grading . . . opens up entirely new fields for progress with better, low-cost drainage.

The strong, welded steel arm of this versatile machine reaches out and pulls dirt . . . or scoops it up and swings it away. All movements of boom and blade are controlled hydraulically. The boom is telescopic and, because of its rigid tubular construction, can be extended 12 feet to a total length of 25 feet.

This is typical of many success stories in which *welded design* has provided potent brainpower for a man's climb upward.

Are you taking advantage of Arc Welding as a means of assuring a secure future? The Lincoln Engineer nearby will be glad to assist you.

THE LINCOLN ELECTRIC COMPANY • Cleveland 1, Ohio

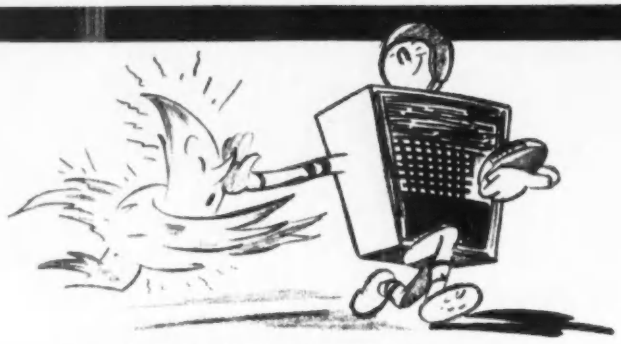
America's greatest natural **recourse**

ARC WELDING

HERE'S ALLIS-CHALMERS' GREAT NEW V-Belt Team!

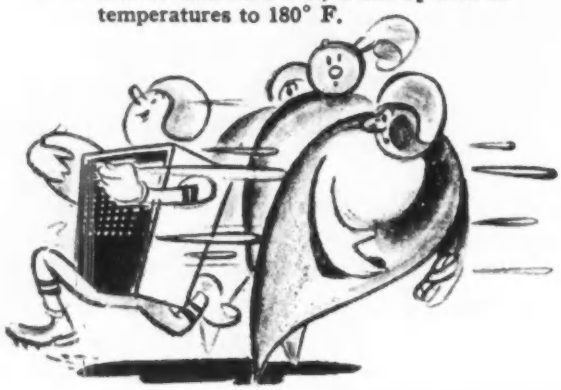
ALLIS-CHALMERS recommendations for belt selections are unbiased . . . because Texrope's V-belt lineup is *complete.* And as inventor of the multiple V-belt drive, A-C offers sound engineering help . . . backed by the world's longest experience in giving industry money-saving drives.

♪ *Tune in-Boston Symphony, Blue Network, Sat. Eves.*



1 **HEAT-RESISTING SUPER-7** has ability to withstand high ambient built right into it. Standard belt, it can operate in temperatures to 180° F.

2 **OIL-RESISTING SUPER-7** is right for drives where fairly bad oil conditions prevail. Neoprene-covered, it resists oil spray and grease.



3 **OIL-PROOF SUPER-7,** is solid Neoprene—a synthetic unaffected by most rubber attacking liquids. Recommended for *extreme* oil conditions.

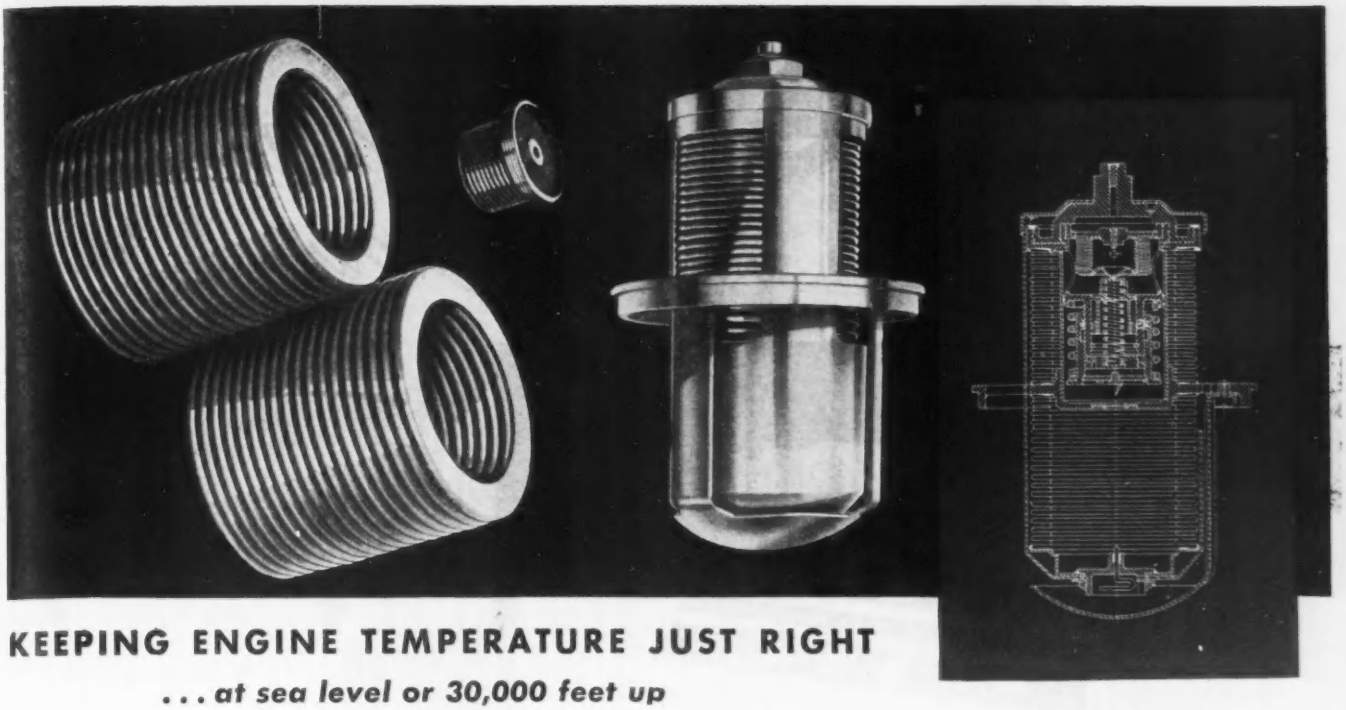
4 **STATIC-RESISTING SUPER-7** *conducts* static charge to machine for grounding charge. This safety belt is applied where explosion danger exists.

5 **SUPER-7-STEEL** employs endless steel cables to provide greater strength, reduce belt stretch. It is ideal for driving extra-heavy loads.

A 1732

IT PAYS TO MAKE ALLIS-CHALMERS YOUR V-BELT DRIVE HEADQUARTERS

Texrope Super-7 V-Belts result from the cooperative research of two great companies—Allis-Chalmers and B. F. Goodrich—and are sold exclusively by A-C.



KEEPING ENGINE TEMPERATURE JUST RIGHT

. . . at sea level or 30,000 feet up

If you have a problem involving the use of a bellows assembly for accurate temperature control, this application of Hydron bellows and the engineering behind it offer evidence that Clifford can help you.

The problem here was to adapt a British aircraft engine by-pass thermostat to American production techniques and practices. Its purpose is to provide for speedy engine warm-up and accurate control of engine operating temperatures regardless of altitude.

Clifford produces this thermostat as shown in the cross-sectional drawing above . . . incorporating three Hydron bellows: a large thermostatic bellows, a large altitude compensator bellows and a small automatic safety bellows. The compensating factor assures most efficient operation at sea level or 30,000 feet up. In making the complete assembly, Clifford fills and tests it to most exacting specifications . . . and it's living up to those specifications in many an aerial combat zone.

FOR BELLOWS FACTS COME TO CLIFFORD FIRST

There's no secret about how Clifford meets the most rigid requirements. Having produced *industry's first hydraulically formed bellows* — Hydron, Clifford is still *first with the facts* about these uniform, pretested metallic bellows. With an engineering staff of Bellows specialists, Clifford is equipped to save you time, trouble and expense in your current or post-war applications of bellows. Write now — before you start designs — for a sample of our facts.

Fill in and mail the coupon below — today.

CLIFFORD

First with the Facts on Hydraulically-formed Bellows

HYDRON

Feather Weight

Feather-weight . . . the First All-Aluminum Aircraft Oil Coolers and Coolant Radiators... Made with Hydron Tubing . . . Brazed by Clifford's Patented Method.

CLIFFORD MANUFACTURING COMPANY

564 E. FIRST STREET, BOSTON 27, MASS.

Please send me a free copy of your 44-page Hydron Bellows Data Book. I am interested in the applications checked.

- ☐ Air conditioners - unit
- ☐ Air conditioning systems
- ☐ Aircraft
- ☐ Carburetor altimeter controls
- ☐ Engine thermostats
- ☐ Gasoline valves
- ☐ High pressure steam devices
- ☐ Hot water heaters
- ☐ Instruments
- ☐ Remote and direct control of temperature and pressure
- ☐ Kilns & ovens — industrial
- ☐ Oil heating systems
- ☐ Oxygen flow indicators
- ☐ Oxygen regulators
- ☐ Process controls
- ☐ Refrigerating systems
- ☐ Refrigerator switches
- ☐ Stoves & ovens — commercial
- ☐ Stoves & ovens — domestic
- ☐ Supercharger controls
- ☐ Refrigerator controls

Other applications .....

NAME .....

COMPANY .....

ADDRESS .....

Beetle *the Plastic that's all Color in all Colors*

Plastic radio cabinet molded for Emerson Radio and Phonograph Corporation by Plastimold, Inc.

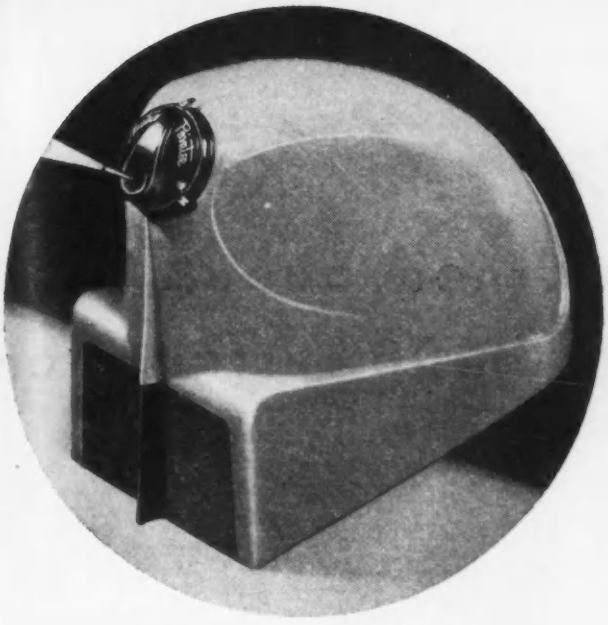
All basic requirements of a successful product housing material are found in BEETLE*. Its brilliant, wide range of colors can be utilized in design for customer appeal and design efficiency. Its surface is smooth and wear-resistant. Its clean, smart appearance and colorful finish last the life of the product. BEETLE has natural insulating properties against heat and electricity. Its adaptability for low cost, volume production enables products to compete profitably on a broad consumer market. Housings are quickly, accurately molded. BEETLE offers a combination of unmatched advantages for modern, distinctive, efficient product housings. Complete information contained in the booklet, "BEETLE Molding Materials," will be sent on request. **Reg. U. S. Pat. Off.*

LIFE ON THE PLASTICS NEWSFRONT

AMERICAN CYANAMID COMPANY • PLASTICS DIVISION

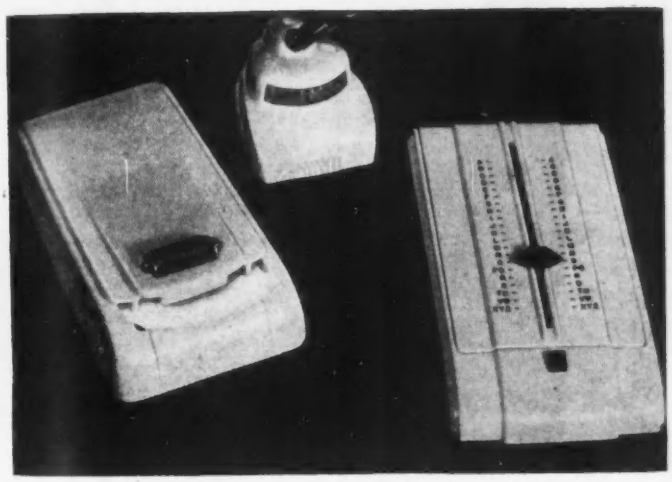
30 ROCKEFELLER PLAZA • NEW YORK 20, N. Y.

Prewar Developments that Point to Postwar Trends in Colorful Plastic Design

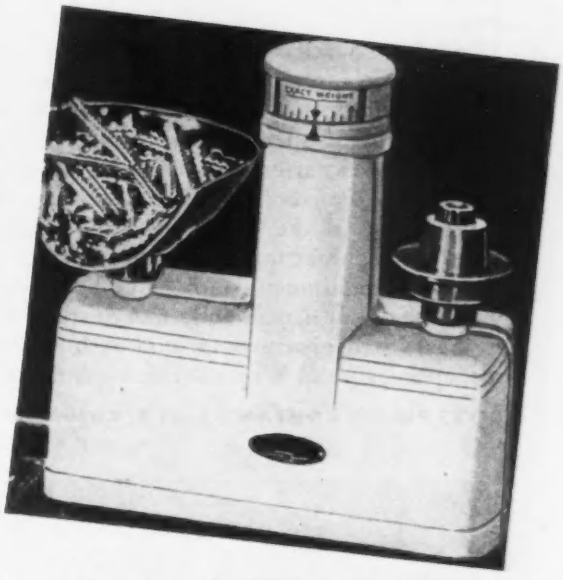


(*Above*) **DISTINCTIVE DESIGNS** are molded with ease and economy as in the attractive and colorful BEETLE housing of this Electro-Pointer pencil sharpener, molded by Kurz-Kasch, Inc.

(*Above*) **SMART, QUALITY APPEARANCE** is achieved on an economical, large-volume basis in the Hammond electric clocks by use of BEETLE housings, molded by Chicago Molded Products Co.



(*Above*) **COLOR** for practical and decorative purposes is illustrated in these Zephyr desk set housings which are virtually ready for assembly as they come complete from the mold.



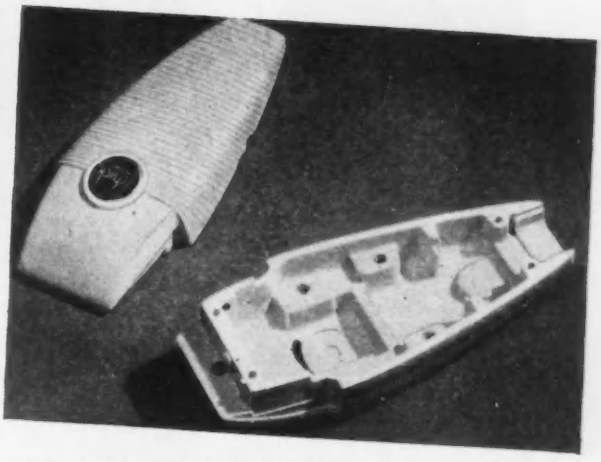
(*Above*) **FUNCTIONAL EFFICIENCY** was improved, costs cut and weight reduced with these Exact Weight Scales BEETLE housings, molded by Kurz-Kasch, Inc.

Cyanamid Plastics

Beetle · Melmac

Melurac · Laminac

Urac



(*Above*) **SMOOTH, WEAR-RESISTANT** surface, sound-deadening and insulating properties of BEETLE proved ideal for Schick Shaver housings, molded by Shaw Insulator Co.

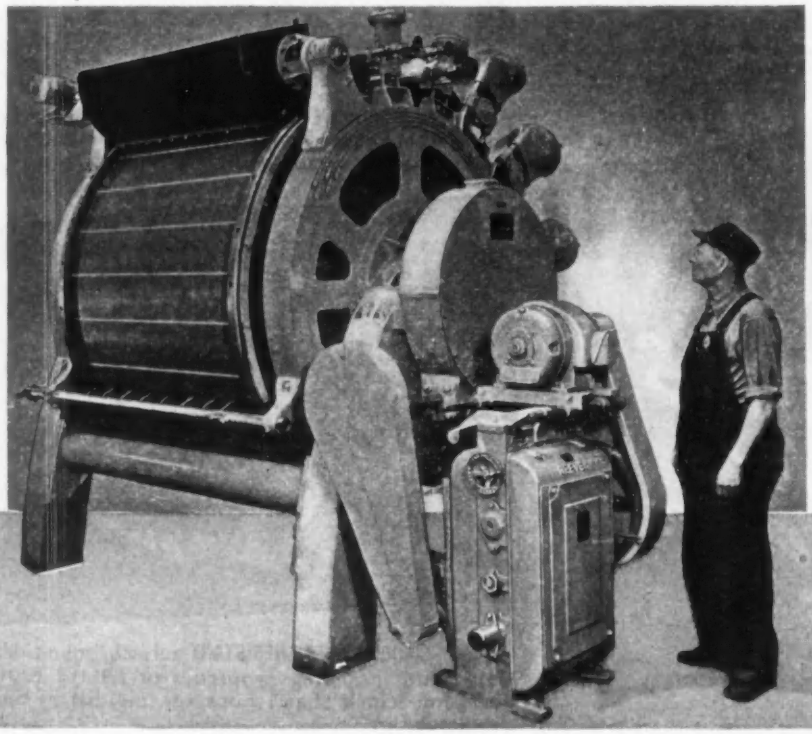
Yours for the Asking . . .

what REEVES has learned about Speed Control from over 260,000 installations

Proved effective in turning out greatly improved production, both in quality and in quantity, in thousands of industrial plants during this war, Variable Speed Control is commanding the interest of more design engineers and machine builders in every field. The question now is *what speed control? Which method is best for the particular requirement? What units are available? What are their operating advantages? How easy are they to service?*

No other source of information is as well qualified to give complete and authentic advice on this subject as REEVES. Recognized leader in the specialized field of speed control engineering, our research and experience covers all types of equipment. More than 260,000 REEVES units are now in service. And the builders of 1,843 different makes of machines furnish REEVES Speed Control as standard equipment. Either our home office or a member of our nation-wide staff of speed control engineers will give prompt and authoritative advice, upon request. Why not ask for it right away?

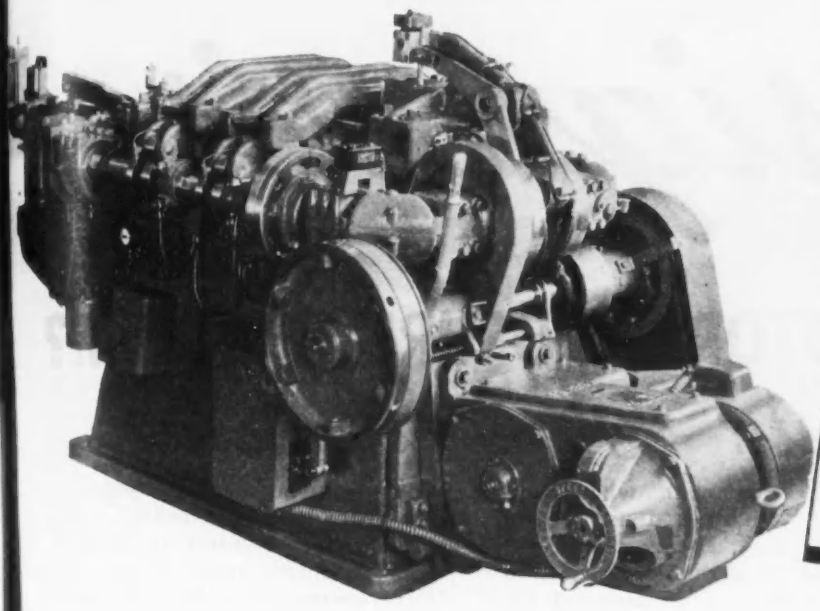
REEVES PULLEY COMPANY, Dept. K, COLUMBUS, IND.



Special type filter, built by Oliver United Filter Co., for handling latex in the manufacture of synthetic rubber. Complete speed flexibility is provided by the REEVES Transmission, vertical enclosed design.

REEVES Units Easy to Service

REEVES units are simple, rugged, accurate—and their complete dependability has been proved over many years. Here's what one user says, "Anybody with a wrench and screw-driver can keep a REEVES Transmission running." And this user has three units that have been operating in his plant since 1904.



REEVES AUTOMATIC SPEED CONTROL

Actuation for automatic control can be taken from many sources, depending on material being processed. REEVES Hydraulic Automatic Control is especially suited to wide applications, being highly sensitive to change in controlled material. Pressure of 2 or 3 ounces produces desired changes in speed. Mechanical and differential also available.

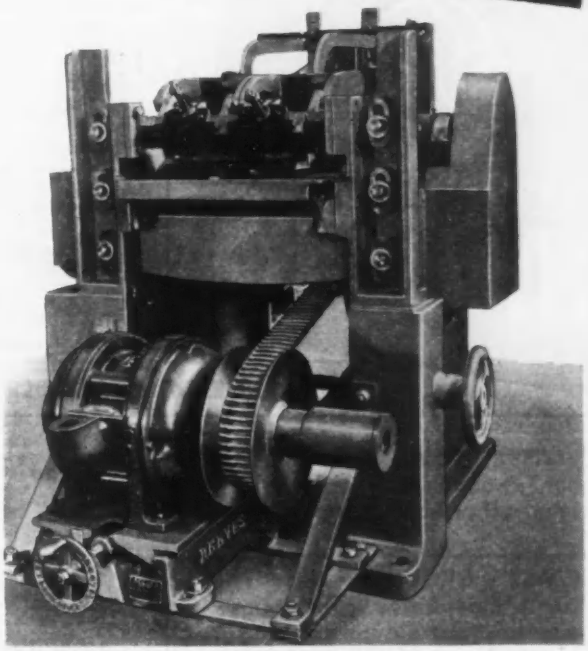
Above: REEVES-driven U. S. Multi-Slide machine for automatic production of intricate metal parts from coil stock. A shaft system completely surrounds the bed of the machine. By means of suitably designed cams and eccentrics, horizontally operating slides, feeding mechanism and embossing heads, etc., are actuated from the shafts. The cam shaft system is driven by the REEVES Motodrive, a complete variable speed power plant, which provides exactly the proper speed for each size and shape of product and kind of material being processed.

★

Battery separator manufacturing machine, pictured right, is driven through a REEVES Vari-Speed Motor Pulley. Merely by turning handwheel, speeds may be varied accurately as required for woods of different degrees of hardness and for producing separators of different thicknesses. This REEVES unit is a simplified development of the Transmission designed especially for light h.p. requirements and speed range within 4:1 ratio. Available with Electric Remote Control.

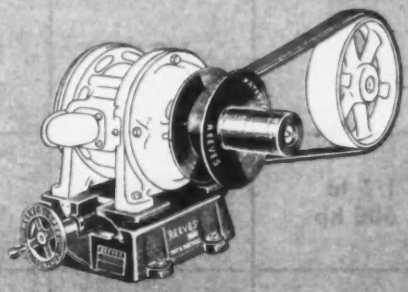
SEND FOR NEW 128-PAGE CATALOG: A complete and authoritative book on Variable Speed Control. Over 200 illustrations, diagrams, tables. Ask for Catalog KG-435.

REEVES PULLEY COMPANY, COLUMBUS, INDIANA

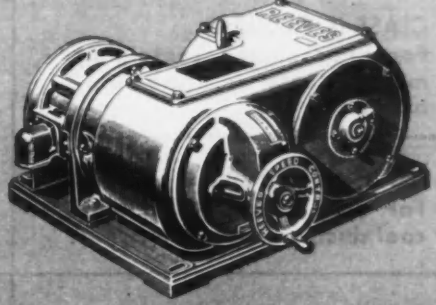


THE 3 BASIC UNITS IN THE MODERN REEVES LINE

MOTODRIVE combines motor, speed varying mechanism and reduction gears in single unit. Speed ratios 2:1 to 6:1 inclusive. Sizes to 15 h.p.



VARI-SPEED MOTOR PULLEY converts any standard constant speed motor to a variable speed drive within 4:1 ratio. Sizes to 15 h.p.



VARIABLE SPEED TRANSMISSION for providing infinite, accurate speed flexibility over wide range —2:1 to 16:1. Sizes fractional to 87 h.p.

REEVES *Accurate Variable* Speed Control

Designer's

WHAT'S YOUR MOTOR-EXPOSURE PROBLEM?

Combustible Dusts? Flammable Gases?

EXPLOSION-PROOF MOTORS

No matter in what hazard your machines must operate, you'll find, as the chart below shows, that there's a G-E motor for the job. The General Electric motors for hazardous-area service include types for every practical need, in a wide range of sizes. They represent the most complete lineup of dust-explosion-proof and gas-explosion-proof motors listed by the Underwriters' Laboratories, Inc.

For complete information on any type—totally enclosed or explosion proof—or for engineering aid in selecting the *right* motor for your machine, call or write our local office. *General Electric Co., Schenectady 5, N. Y.*

	Polyphase Squirrel-cage	Polyphase Wound-rotor	Single-phase	Direct-current
RANGE OF AVAILABLE HORSEPOWER RATINGS				
CLASS I, GROUP C For atmospheres containing ethyl-ether vapor, etc.	1/2 to 15 hp		1/20 to 1/3 hp	1/20 to 1/2 hp
CLASS I, GROUP D For atmospheres containing gasoline, petroleum, naphtha, alcohols, acetone, solvent vapors, natural gases, etc.	1/8 to 1000 hp	1/2 to 500 hp	1/20 to 5 hp	1/20 to 30 hp
CLASS II, GROUP E For atmospheres containing metal dusts—magnesium, aluminum, etc.	1/8 to 75 hp	1/2 to 60 hp	1/20 to 10 hp	1/20 to 30 hp
CLASS II, GROUP F For atmospheres containing coal dust, coke dust, etc.	1/8 to 600 hp	1/2 to 250 hp	1/20 to 10 hp	1/20 to 30 hp
CLASS II, GROUP G For atmospheres containing grain dust, etc.	1/8 to 600 hp	1/2 to 250 hp	1/20 to 10 hp	1/20 to 30 hp

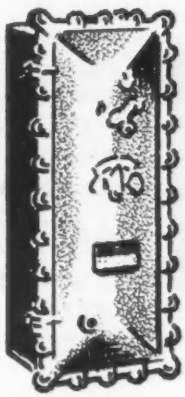
GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E PRODUCTS

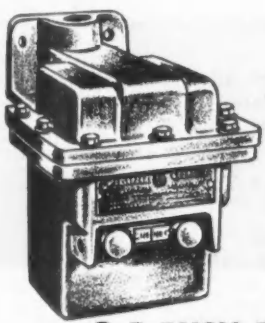
. . . . . and here's CONTROL FOR HAZARDOUS AREAS

You'll find that G.E. also has an exceptionally wide range of dependable, efficient control, including both oil-immersed and air-break types. Typical G-E controls for Class I, Group D, conditions are shown below.



For Class I, Group D, locations, this air-break combination starter combines air circuit breaker and magnetic starter in one compact unit. Made of cast, high-strength alloy, with accurately ground, tight-fitting flanges, these starters can withstand internal explosions and prevent escape of hot gases.

G-E AIR-BREAK COMBINATION STARTER



Suitable for corrosive and hazardous-gas locations, this push-button station has contacts which operate under oil. Entire unit is enclosed in cast-iron case specially finished to withstand acid fumes, alkali dust, or exposed outdoor service.

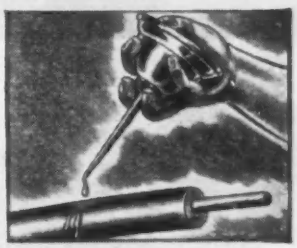
G-E PUSH-BUTTON STATION

These oil-immersed combination starters operate with all contacts at least six inches under oil. Easy-to-read indicator provides safety check on oil level. Extra-tough exterior finish provides protection from corrosion caused by chemical fumes or exposure to weather.

G-E OIL-IMMERSED STARTER

Buy all the BONDS you can—
and keep all you buy

The cable that OIL won't SPOIL



The insulation on G-E Flamenol* cable is a rubber-like compound that is highly resistant to the action of oils, acids, and alkalies. That's why it's the cable to use in wiring-up motors and controls that operate machine tools.

G-E Flamenol is flame-resistant. It will not support combustion. (More than 100,000,000 feet in service.)

From the installation standpoint, G-E Flamenol saves time and trouble. Because of its smooth surface and small diameter, it is easy to fish through conduit. Ask for Bulletin GEA-3280A.

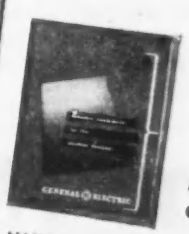
Compact CAPACITANCE

Combining stable, uniform characteristics with unusual compactness and resistance to vibration, excessive humidity, and the effects of extremes of temperature and high altitudes, G-E small Pyranol* capacitors have proved themselves in a wide variety of applications.

These capacitors are ideal for fluorescent-lamp ballasts, motors, industrial controls, and electronic equipment. Their high capacitance per cubic inch contributes to compact designing, and their strong construction assures long, dependable service.

G-E small Pyranol capacitors are available in more than 350 standard ratings, and in many shapes and sizes. Ask for bulletins GEA-2027 (a-c) and GEA-2621 (d-c).

*Trade-mark Reg. U.S. Pat. Off.



General Electric Company, Section C668-36, Schenectady 5, N. Y.

Please send me your Bulletins GEA-2027 and GEA-2621 on Pyranol capacitors, and GEA-3280A about G-E Flamenol wire.

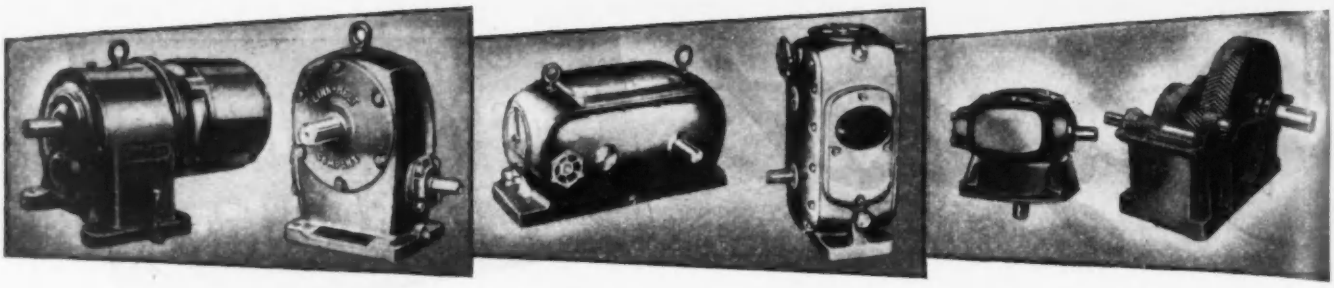
NAME .....

COMPANY .....

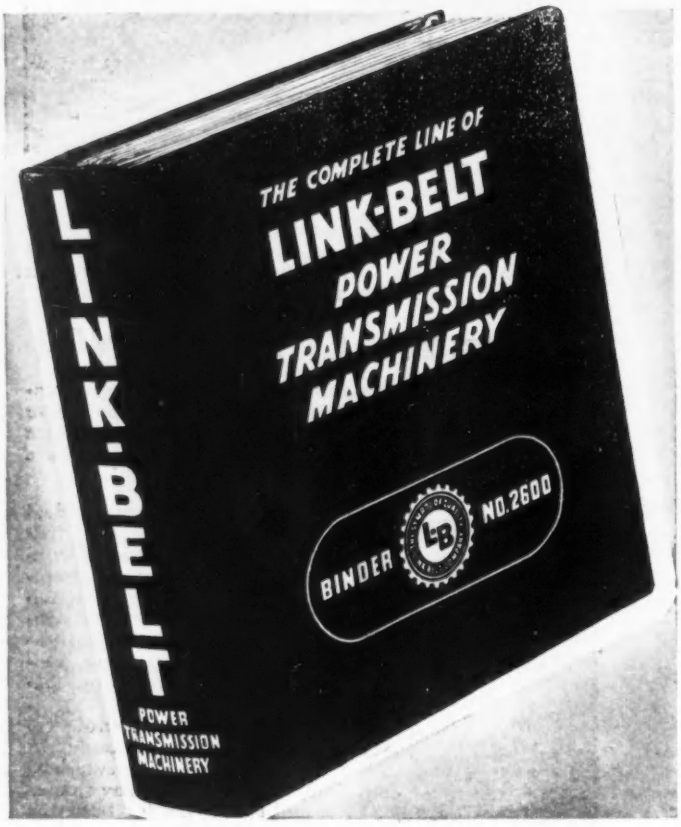
ADDRESS .....

CITY ..... STATE .....

5679



AT YOUR SERVICE . . . The



Link-Belt catalogs contain abundant engineering and application data on the fields served. While wartime restrictions limit the supply of the complete binder, No. 2600, individual catalogs on each item listed at the right, are available. Consult Link-Belt freely on any phase of mechanical power transmission.

SILVERSTREAK SILENT CHAIN DRIVES
Catalog 125

SILVERLINK ROLLER CHAIN DRIVES
Catalog 1957

DRIVE CHAINS—Malleable Iron, Promal & Steel
Catalog 1994

ROLLER & BALL BEARINGS—Catalog 1775-A

BALL & ROLLER BEARING PILLOW BLOCKS
All Types—Catalog 1775-A

BALL & ROLLER BEARING UNITS
Duplex, Flange, Cartridge, etc.—Catalog 1775-A

BABBITTED BEARING PILLOW BLOCKS
All Types—Catalog 1997

BABBITTED BEARING UNITS
Flange, Step, Post, etc.—Catalog 1997

COUPLINGS—Rigid, Flexible, Compression—
Catalog 2045

POWER TRANSMISSION ACCESSORIES
Shafting, Collars, Base Plates, Take-Ups, Grease Cups, Hangers, Clutches, Pulleys, Gearing—
Catalog 1997

SPROCKETS—Cut & Cast Tooth—Catalog 850

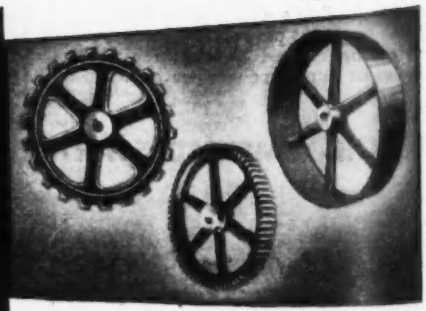
SPEED REDUCERS
Worm Gear—Catalog 1824
Herringbone Gear—Catalog 1519-A
Motorized Helical Gear—Catalog 1515

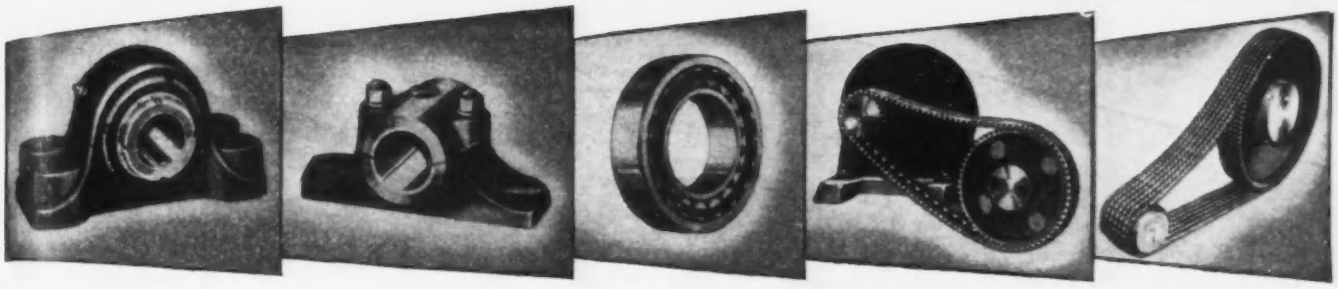
VARIABLE SPEED CHANGERS
P. I. V. Gear—Catalog 1874
Variable Roller Drive—Catalog 1374
(Motorized & Gear Set Types)

V-BELT DRIVES

THE SYMBOL OF QUALITY · LINK-BELT COMPANY · LB

ONE → NAME TO REMEMBER
→ DEPENDABLE SOURCE OF SUPPLY
→ HIGH STANDARD OF QUALITY
→ RESPONSIBILITY FOR PERFORMANCE





Complete LINK-BELT *Line of* POWER TRANSMISSION MACHINERY

"Complete," in Link-Belt language, means more than merely representing every class of equipment; it means not merely that Link-Belt offers *a* speed reducer, but a *line* of speed reducers, including all three standard types, in a full range of sizes and types of mounting; it means that Link-Belt chain includes silent, roller, malleable iron, Promal or steel—light- and heavy-duty types—for all purposes and in any size required. The same is true of Link-Belt speed variators, clutches, sprockets, gears and couplings, pulleys, collars . . . in every group, a complete assortment of styles and sizes is available.

And finally, when you come to Link-Belt for equipment and counsel, you receive the impartial recommendations of specialists who can supply the correct type and size of unit needed, from a line noteworthy for its high engineering standards and efficient performance.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Toronto 8.
Offices, Factory Branch Stores and Distributors in principal cities.

Chicago Plants — Indianapolis Plant — Ordnance Plant — San Francisco

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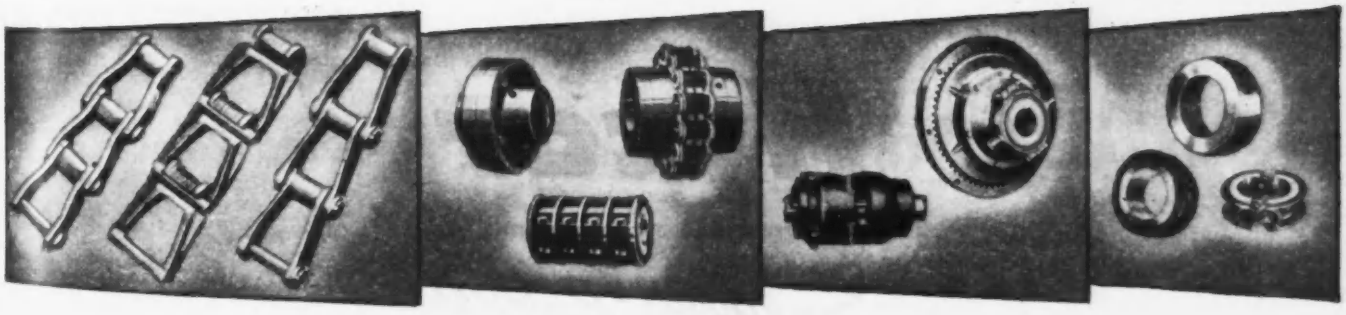
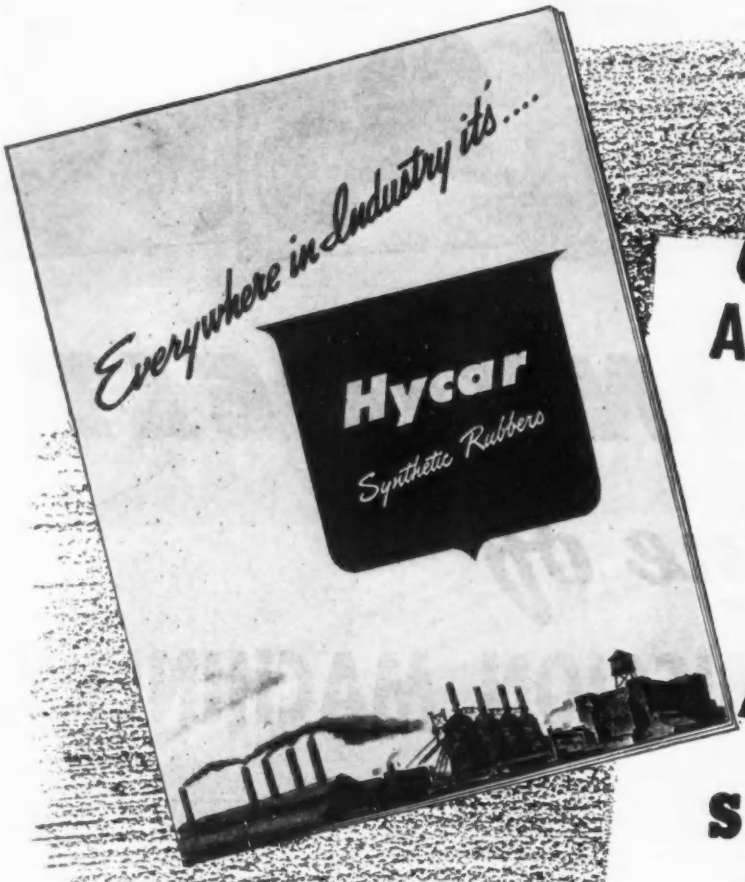




FREE

A New, Interesting Informative Booklet about Hycar

Reg. U. S. Pat. Off.

SYNTHETIC RUBBERS

THERE is no limit to the use of resilient rubber parts having the right combination of the properties listed in the box at the right. That's why you'll want a copy of "Everywhere in Industry". It's a new, easy-to-read, generously illustrated 16-page booklet containing information that's new . . . up-to-the-minute! It covers the many important developments in Hycar synthetic rubbers that have been made in the last 3 years.

The booklet describes Hycar's characteristics in detail, provides technical data that will be helpful in suggesting new applications for this material. "Everywhere in Industry" will help you in your present and future plans.

Because of its many desirable properties, the potential uses of Hycar throughout industry are so broad it is impossible to know all the ways in which it may be advantageously used. As new applications occur to you, and you need help developing them, please call on our Technical Service Staff. And . . .

for your FREE copy of

"Everywhere in Industry"

write Department 0-1, Hycar Chemical Company, Akron 8, Ohio.

Check These Superior Features of Hycar

1. **EXTREME OIL RESISTANCE**—insuring dimensional stability of parts.
2. **HIGH TEMPERATURE RESISTANCE**—up to 250° F. dry heat; up to 300° F. hot oil.
3. **ABRASION RESISTANCE**—50% greater than natural rubber.
4. **MINIMUM COLD FLOW**—even at elevated temperatures.
5. **LOW TEMPERATURE FLEXIBILITY**—down to —65° F.
6. **LIGHT WEIGHT**—15% to 25% lighter than many other synthetic rubbers.
7. **AGE RESISTANCE**—exceptionally resistant to checking or cracking from oxidation.
8. **HARDNESS RANGE**—compounds can be varied from extremely soft to bone hard.
9. **NON-ADHERENT TO METAL**—compounds will not adhere to metals even after prolonged contact under pressure. (Metal adhesions can be readily obtained when desired.)

Hycar

Reg. U. S. Pat. Off.

LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

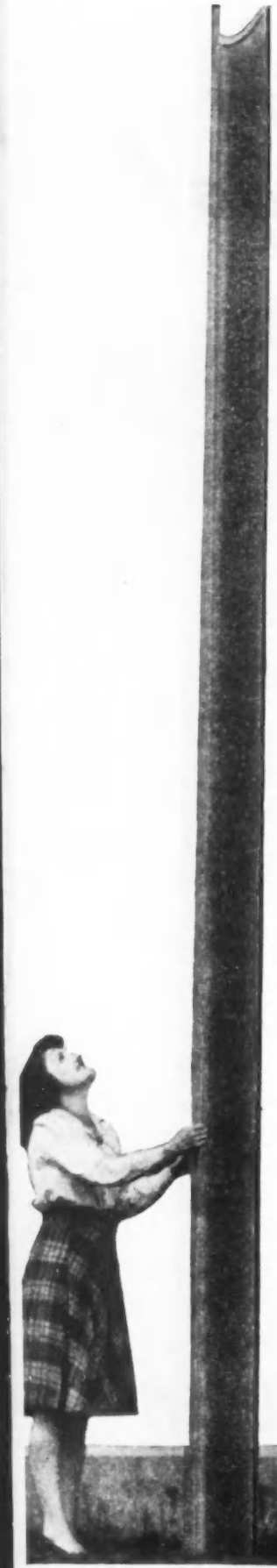
Synthetic Rubbers

WHAT you gain by having skilled spring engineers design your springs is vividly demonstrated in Adel's "Mighty Midget" Hydraulic Selector Valve. 76% lighter and 72% smaller than previous designs, this unit measures only 1½" x 2½" x 2¼". Considering these dimensions, you can well imagine the tiny size of the Muehlhausen Springs—the nerve center of the "Midget's" operation.

These springs are tiny in size only. Their operating characteristics and the amount of engineering skill that goes into them would cause many a man-size spring to take a back seat. Designed to meet precisely every requirement of the job, these springs were a vital factor in the development of this remarkable valve.

Improvement in product performance and added product life are always assured when using *designed* springs. MUEHLHAUSEN SPRING CORPORATION *(Division of Standard Steel Spring Company)*, Michigan Avenue, Logansport, Indiana.

***To improve product performance, use* MUEHLHAUSEN Designed SPRINGS**



SIZE IS NOT THE ONLY MEASURE

This seventeen foot low pressure molded part is the longest plastics part ever manufactured. However, plastics' ability to do a specified job is of much more importance than its dimensional versatility. At General Electric the manufacture of parts from the size of a pinhead to sections as large as the illustrated housing is all in a day's work. The first consideration for any plastics part should be quality, and the problem of size is solved at General Electric by complete range of manufacturing equipment. Because G-E production facilities encompass every phase of molding and laminating, you can be assured of an unbiased recommendation of which material and which process—a most important consideration for your product. Write Section F-26, One Plastics Avenue, Pittsfield, Mass. or call the Plastics Divisions Office nearest you for the advice of a skilled technician.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS.

Buy War Bonds

A G-E PLASTICS TECHNICIAN *KNOWS* PLASTICS

FD-26

GENERAL ELECTRIC

Seventeen Foot Radar Housing Manufactured For The Douglas Aircraft Co. Inc.

WORTH GETTING "STEAMED-UP" ABOUT

Designed by Brooks Stevens, molded by Raymond Laboratories for The Spartan Co., Minneapolis

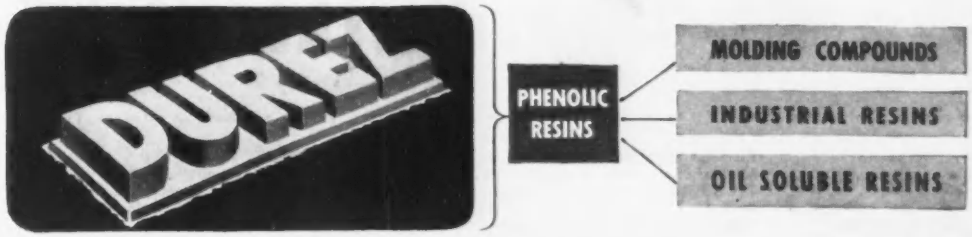
The Spartan vaporizer illustrated above is a brand new development in humidifying equipment. Entirely automatic, this vaporizer holds a full half-gallon of water and gives off steam immediately even though the water is ice cold. The unusual design and ingenious mechanical principle of this unit typify the progressiveness of American industry in developing new products and improving old ones with plastics

The ever-increasing usage of Durez phenolic molding compounds by manufacturers throughout industry is due directly to two reasons.

First is the unusual versatility of the phenolics. These most versatile of all plastics possess such desirable properties as excellent moldability, highest dimensional stability, diversity of finishes, dielectric strength, and resistance to heat, moisture, acids and alkalies.

Second is the rich background which Durez technicians have acquired through *specializing* in the production of phenolics during the past quarter century. They have participated in the successful development of thousands of different products, supplying in each case a plastic that fitted the job. In many instances, the finished product was not all-plastic but consisted of a combination of plastic and metal. A good example of this is the above illustrated Spartan vaporizer. The lower container, inner elements, knobs and handles were molded from a Durez phenolic compound. The cover is a satin-finish aluminum stamping.

Undoubtedly you are working out the development plans for a product which is scheduled for post-victory marketing. Naturally you are considering the use of plastics in this connection. The benefits of our broad experience plus the wealth of data collected in our files are at your disposal at all times. Durez Plastics & Chemicals, Inc., 302 Walck Road, North Tonawanda, N. Y.



PLASTICS THAT FIT THE JOB

IT'S A PRODUCTION PLUSSER!

Time was when this manufacturer of magneto housings used slotted screws *and* helical inserts to fasten heads to withstand flight vibrations. Though expensive, this laborious, 2-step hand operation never produced completely vibrationless fastenings.

IT'S A COST REDUCER!

By switching to Phillips Recessed Head Screws, this manufacturer turned a slow-motion process into a fast, 1-step power operation, got a truly vibration-proof fastening. He also sliced fastening material costs about 71%, assembly costs correspondingly!

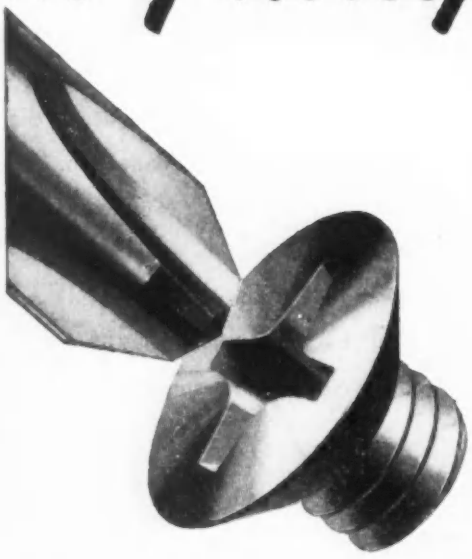
IT'S A STRENGTH BUILDER!

Besides being more efficient from assembly and cost angles, Phillips Screws are better from the design angle. Engineered to stand heaviest driving pressures, they take *any* load you need to impart product strength and rigidity.

IT'S AN ORDER GETTER!

From the sales angle, too, Phillips Screws are in a class by themselves. They snap up appearance of any product . . . make it stronger . . . and banish the burred screw heads that mar smooth surfaces, snag clothing, sabotage sales.

It's Phillips — the engineered recess!



In the Phillips Recess, mechanical principles are so correctly applied that every angle, plane, and dimension contributes fully to screw-driving efficiency.

. . . It's the exact pitch of the angles that eliminates driver skids.

. . . It's the engineered design of the 16 planes that makes it easy to apply full turning power – without reaming.

. . . It's the "just-right" depth of recess that enables Phillips Screw Heads to take heaviest driving pressures.

With such precise engineering, is it any wonder that Phillips Screws speed driving as much as 50% – cut costs correspondingly?

To give workers a chance to do their best, give them faster, easier-driving Phillips Recessed Head Screws. Plan Phillips Screws into your product now.

PHILLIPS *Recessed Head* SCREWS

WOOD SCREWS • MACHINE SCREWS • SELF-TAPPING SCREWS • STOVE BOLTS

Made in all sizes, types and head styles

24 SOURCES

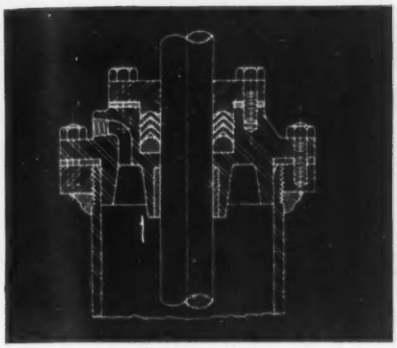
American Screw Co., Providence, R. I.
Atlantic Screw Works, Hartford, Conn.
The Bristol Co., Waterbury, Conn.
Central Screw Co., Chicago, Ill.
Chandler Products Corp., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
The Corbin Screw Corp., New Britain, Conn.
General Screw Mfg. Co., Chicago, Ill.
The H. M. Harper Co., Chicago, Ill.
International Screw Co., Detroit, Mich.
The Lamson & Sessions Co., Cleveland, Ohio
Manufacturers Screw Products, Chicago, Ill.
Milford Rivet and Machine Co., Milford, Conn.
The National Screw & Mfg. Co., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I.
Pheoll Manufacturing Co., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Russell Burdsall & Ward Bolt & Nut Co., Port Chester, N.Y.
Scovill Manufacturing Co., Waterville, Conn.
Shakeproof Inc., Chicago, Ill.
The Southington Hardware Mfg. Co., Southington, Conn.
Wolverine Bolt Co., Detroit, Mich.

GRATON & KNIGHT ENGINEERS PRESENT

PACKINGS POINTERS No. 10

Handy, file-size folders of each article in the series, including additional information, are available, free. Write to Packings Department, 321 Franklin St., Graton & Knight Company, Worcester 4, Mass.

3 Methods for Packing Gland-Type Recesses



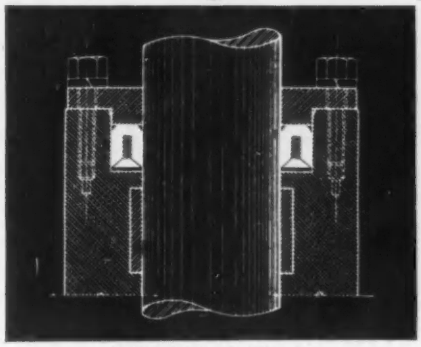
VEE PACKINGS (Fig. 1)

Their characteristics:

A completely mechanical seal
Can be used with either reciprocating or rotating shaft and under any desired pressure
Can be installed solid, or can be split and installed with joints staggered around the shaft
Will give the best service
Will have the longest life
Are somewhat more difficult to install
Can be spring-loaded — very desirable in some applications
Recess requires more machining than for either a U or flange packing.

Select for:

Reciprocating or rotating application
Wide range of pressures
Long, trouble-free service
Minimum of shutdowns during work cycle.



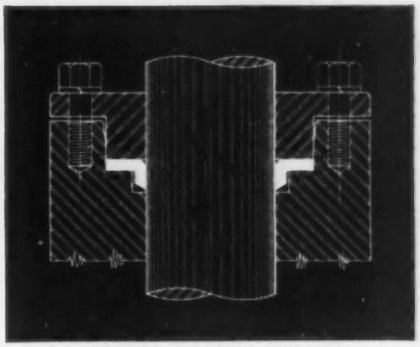
U PACKING (Fig. 2)

Its characteristics:

A completely mechanical seal
Is adaptable to slow-speed reciprocating shafts, plungers or rams
Can be used in an inside recess
Is easy to install
Will give good service
Has good life, although not as long as set of Vees
Is easy to replace — either by removing plunger or installing packing over it or by installing packing around plunger with an open lap
Simple, square recess requires minimum machining.

Select for:

Large reciprocating shafts
Inside cylinder recess
Low first cost.



FLANGE PACKING (Fig. 3)

Its characteristics:

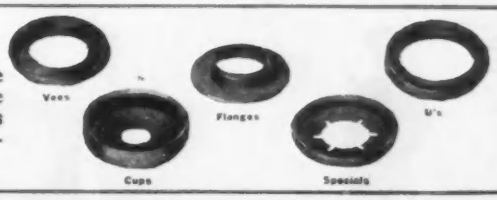
Performs satisfactorily with either reciprocating or rotating shaft
Is easily installed
Cannot be split for installation around shaft
Flanged section is sealed by compression
Service life is equal to that of U, but not that of Vees
Can be replaced only by removing shaft, or by installing the packing over the shaft
Recess requires less machining.

Select for:

Retainer, oil seal or dust seal
Removable shaft or assembly over shaft
Low first cost required
Quick replacement or periodic removal and re-installation.

SPARTAN LEATHER PACKINGS

Graton & Knight's SPARTAN - has highest resistance to abrasion and heat (withstands boil test), is unaffected by common pressure mediums, and will not dry out hard and brittle. It also has exceptional tear and tensile strength. When your design reaches the "packings point" — or when packings trouble occurs — call on G&K engineers.



World's Largest Manufacturer of Industrial Leather Products

SPARTAN ENGINEERED PACKINGS

GRATON & KNIGHT COMPANY

Worcester 4, GRATON AND KNIGHT Massachusetts

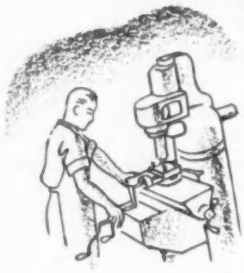
Gibson Springmaking safeguarded at 6 vital stages

1 SOUND DESIGN

Existing specifications checked by qualified engineers in the light of recent developments and improvements. Creative design and experimental work for new mechanisms.

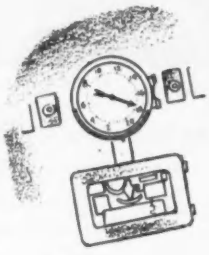
4 EFFICIENT PRODUCTION

Springs assigned to individual department best equipped in tools, machines and manpower for type and volume required. Small orders filled in special department.



2 SKILLED TOOLS

Step-by-step analysis of operations required to produce spring — for combinations of motions necessary, based on intricacy of shape or production volume desired.



5 CONTROLLED HEAT-TREATING

Fully-automatic continuous furnaces under direct laboratory supervision give accurate, uniform results so important to spring installation and lasting performance.

3 APPROVED MATERIALS

Careful selection and examination of steels and alloys for uniformity and content—stocks graded for stress ranges based on actual tests.

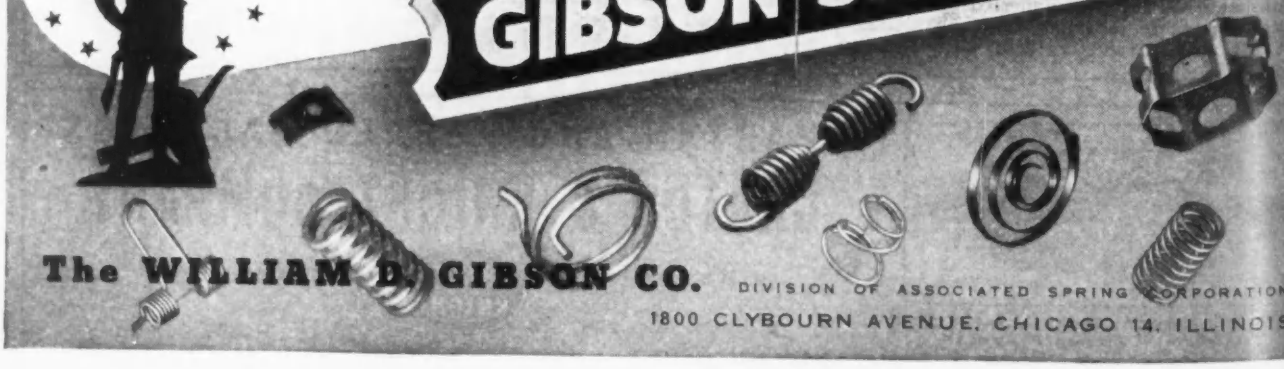
6 SELECTED TESTS

Standard fatigue-testing equipment plus specially designed mechanisms to simulate actual operating conditions—magna flux and stroboscopic equipment.

LET GIBSON ENGINEERS SAFEGUARD *YOUR* SPRING REQUIREMENTS

ARMY E NAVY

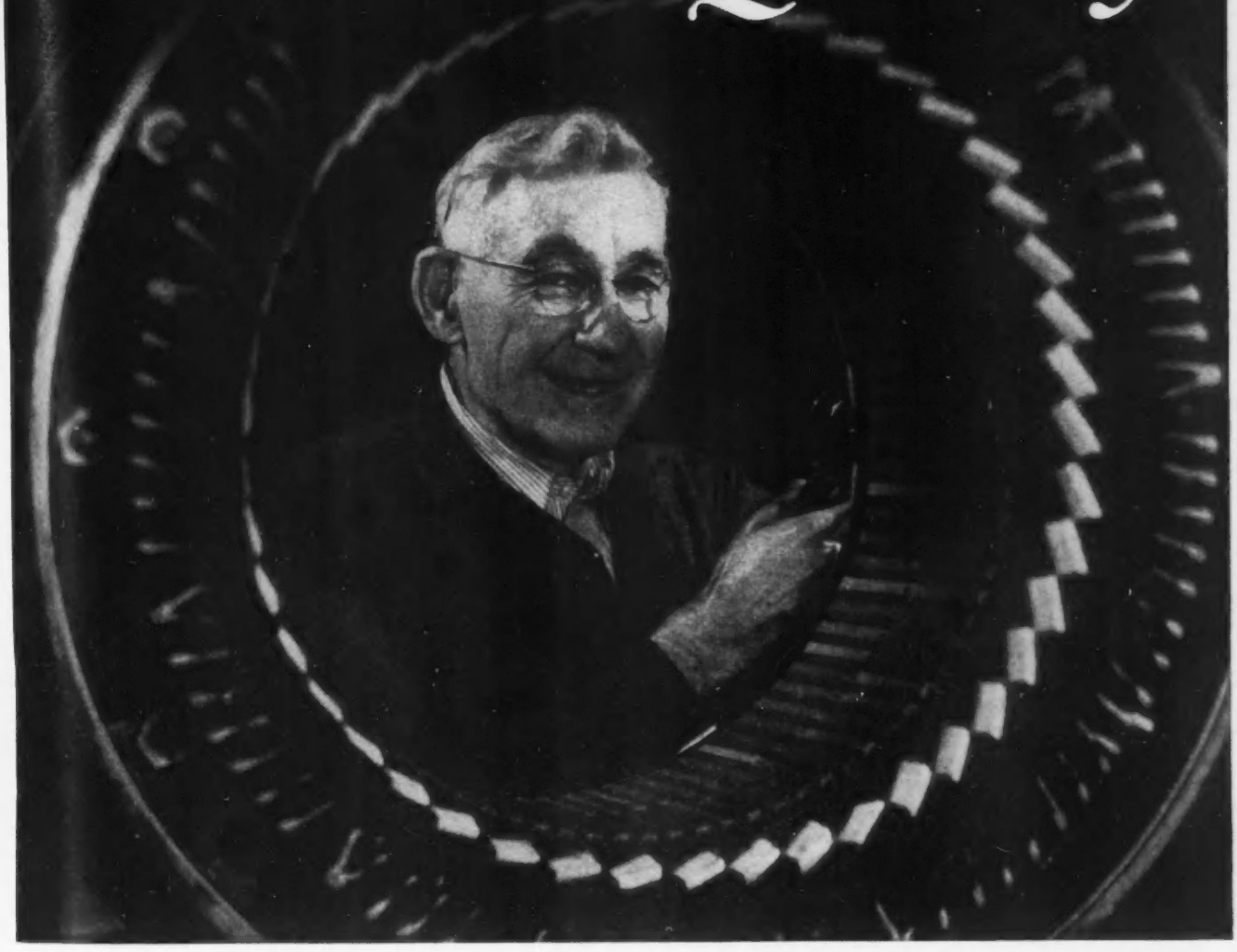
GIBSON SPRINGS



The WILLIAM D. GIBSON CO. DIVISION OF ASSOCIATED SPRING CORPORATION

1800 CLYBOURN AVENUE, CHICAGO 14, ILLINOIS

Meet Mr. Quality



ONE LOOK AT Bill Seebode — 50 year man at Allis-Chalmers Norwood Works — tells you that he sleeps well nights.

One reason is that he and hundreds of his fellow craftsmen at Allis-Chalmers have won *and are keeping* the confidence of engineers and operating men throughout American Industry.

That means a lot to veterans like Bill who've made a career of building great motors.

Bill's a stator-winder, as you can see—a living example of the truism that *men* make motors.

No machine known can assemble the maze of wiring and insulation that goes into a stator with his skill and care. No machine can fully test how *well* he's done his job.

There's only one test . . . wait 5, 10, 15 years and *see*.

And that's the test that has proved Allis-Chalmers motors are *great* motors. That's why you hear it said so often: *"You can depend on Allis-Chalmers Motors!"*

Yes, hundreds of Allis-Chalmers men—*quality* men like Bill Seebode — know they have a big personal stake in every Allis-Chalmers motor. When they build a great motor for you, they're making a friend . . . and they know that's something no company and its workers can have too many of. ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

• • •

♪ *Tune in the Boston Symphony, Blue Network, Saturday at 8:30 pm, EWT.*

A 1729

YOU CAN DEPEND ON ALLIS-CHALMERS MOTORS

FROM ONE 200" MIRROR TO BILLIONS OF LIGHT BULBS

Corning physicist examining ribbed structure of 200" mirror with polariscope.

SINCE the time it produced the glass bulb for Thomas A. Edison's first electric light in 1879, Corning has been supplying bulbs to nearly every manufacturer of electric light bulbs in America. To date billions have been manufactured on high speed automatic machines that produce them at the rate of hundreds per minute.

Here is a mass production process that turns out huge quantities of a glass product at a fraction of a cent apiece. Yet, significantly, it was the same facilities, the same engineering skill that produced the largest single piece of glass ever made—the 200" Mt. Palomar Telescope Mirror.

Only Corning has these facilities that can produce a single piece of glassware for a very special application and where cost is no consideration . . . or a million pieces made on Corning designed high speed machinery at quantity production prices. In developing new products and in redesigning you can be sure of finding at Corning the glass knowledge, the "know-how," and manufacturing facilities for meeting your requirements with glass. With thousands of glass formulae from which to choose, with the engineering skill to turn out glass parts economically, Corning may provide a solution to your problems. It will pay you to consult Corning Engineers. Write now.

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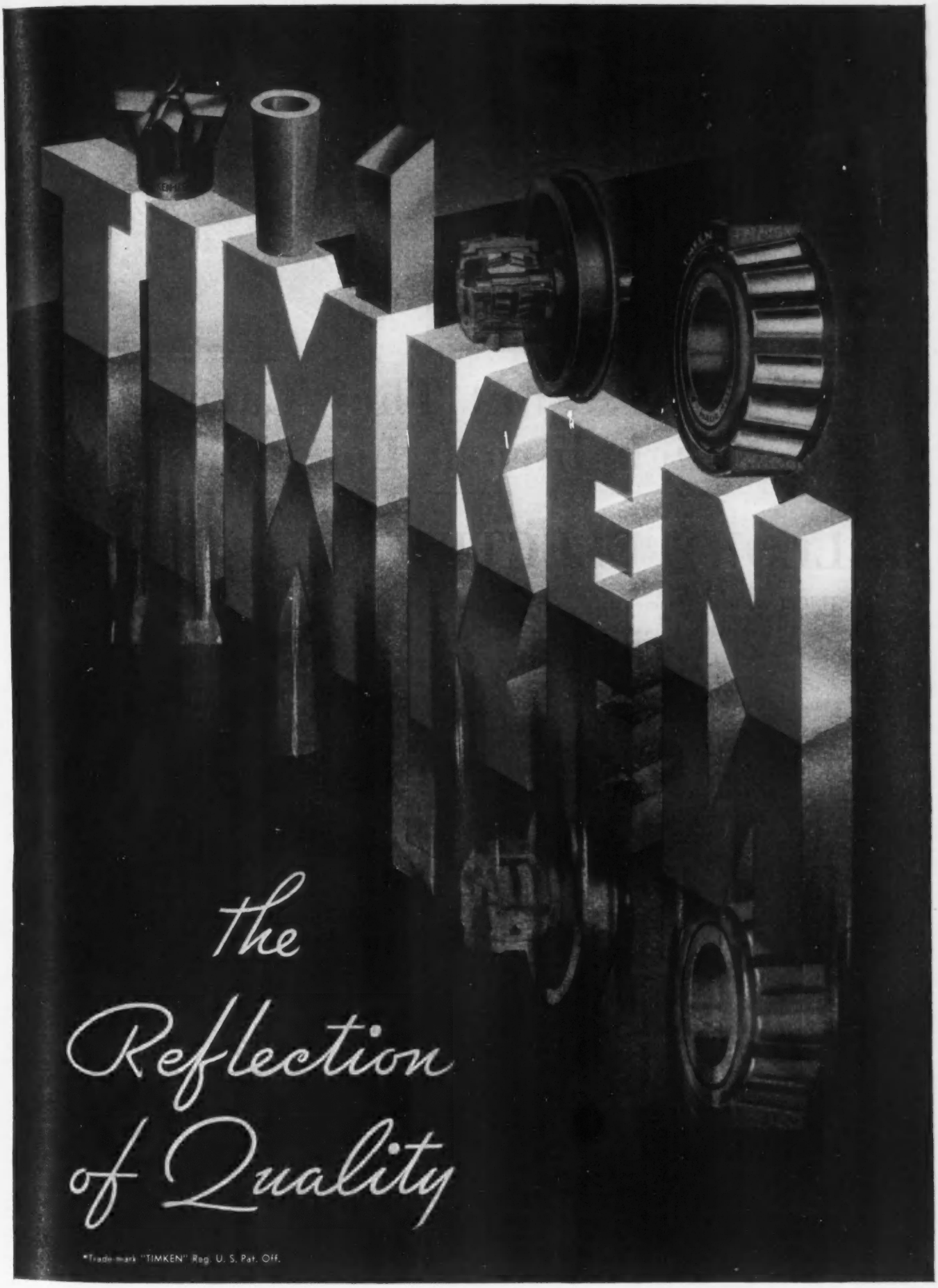
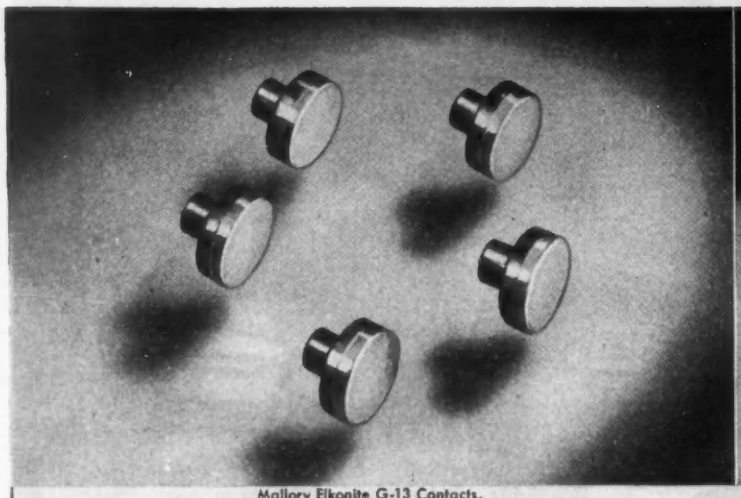
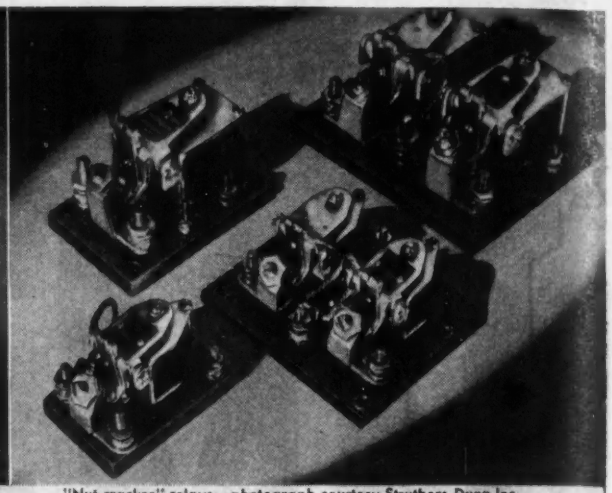


TIMKEN Tapered Roller Bearings — **TIMKEN** Alloy Steels — **TIMKEN** Seamless Steel Tubing — **TIMKEN** Railway Roller Bearings — **TIMKEN** Rock Bits



Mallory Elkonite G-13 Contacts.



"Nut cracker" relays—photograph courtesy Struthers-Dunn Inc.

Small... But They Carry High Inrush Loads...

MALLORY ELECTRICAL CONTACTS

ELECTRICAL contacts for these "nut cracker" relays must be *small*—space is at a premium. They must be *tough*—to stand shock and vibration. Contacts must be *electrically rugged*—to carry as much as 1000 amperes inrush current at 24 volts DC.

Mallory metallurgists and contact engineers have helped the relay manufacturer to find exactly the right contact material to meet these rigorous requirements. Elkonite* G-13, developed by Mallory, efficiently carries the high current load with no welding or arcing.

Its toughness meets physical "specs" not only for impact strength but also for wear resistance—assuring long life.

Elkonite compound metals may be the answer if you're seeking materials for contacts or contact assemblies with unusual electrical and physical properties. With Elkonite G-13 and the related G-12 and G-14 materials, there is a sufficient range of properties to cover applications from relatively low current switches and relays up to heavy-duty circuit breakers.

Consult experienced Mallory engineers on your contact and contact assembly problems. Often they can suggest complete assemblies that simplify your designs, save you fabricating time, and assure a more efficient product.

TYPICAL PHYSICAL PROPERTIES OF ELKONITE G-13

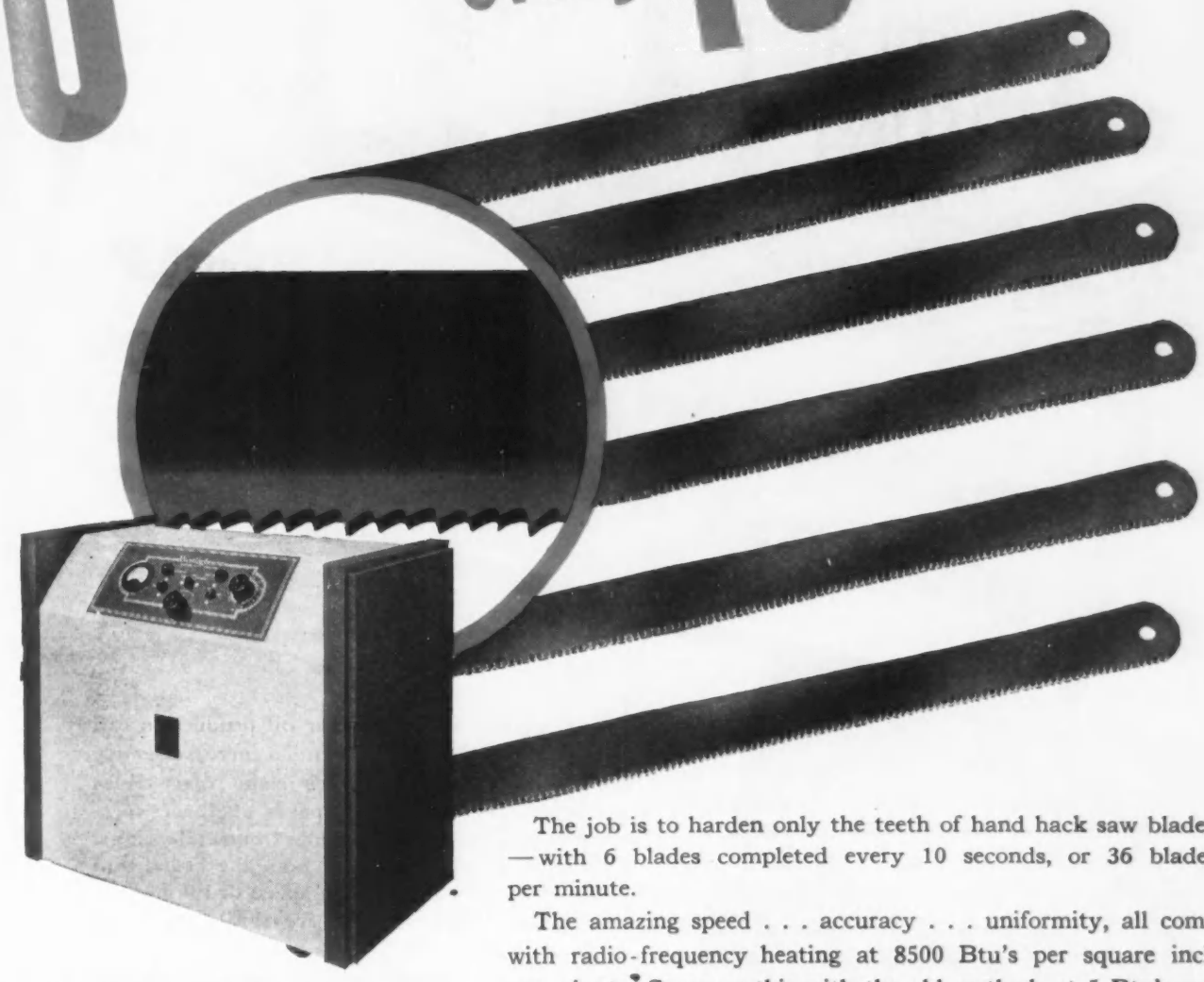
Grams per cc.	12.3
Lbs. per cu. in.	0.45
Conductivity %I.A.C.S.	55-60
Rockwell Hardness	70-80B
Tensile Strength psi	40,000
Cross Breaking Strength psi	115,000

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

*Elkonite: trademark registered by P. R. Mallory & Co., Inc., for electric contacting elements.

ELECTRICAL CONTACTS AND CONTACT ASSEMBLIES

6 blades hardened every 10 seconds



10 KW RADIO-FREQUENCY GENERATOR

This unit has many applications. Its "table top" work surface eliminates the need for small tables, and all controls are centralized on the sloping panel. Large sturdy casters provide speedy mobility.

The job is to harden only the teeth of hand hack saw blades —with 6 blades completed every 10 seconds, or 36 blades per minute.

The amazing speed . . . accuracy . . . uniformity, all come with radio-frequency heating at 8500 Btu's per square inch per minute. Compare this with the old method, at 5 Btu's per square inch per minute.

Similar high speeds are possible in every metal heating job—annealing, hardening, brazing, sintering, forging and soldering. And the heating is so simple that it's a "push button" job for unskilled help.

Another great advantage comes with Westinghouse design . . . a single shielded cabinet contains generating equipment and controls, easy to install and maintain . . . requiring a minimum of space.

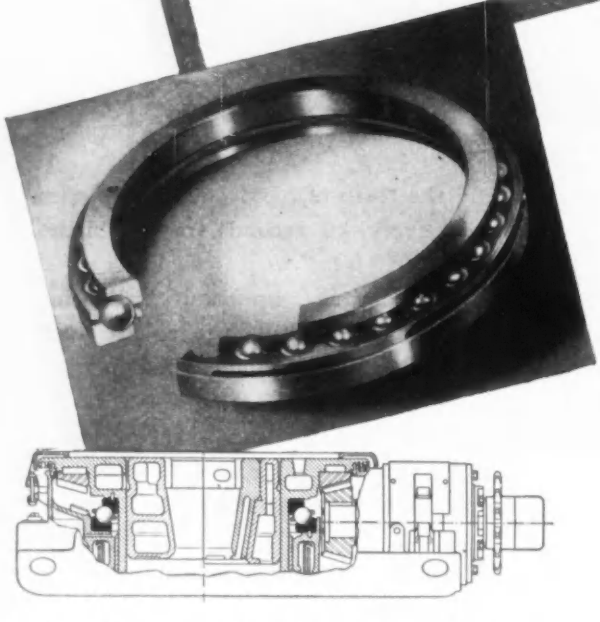
Westinghouse Radio-Frequency Generators for induction or dielectric heating are available in eight different standard sizes up to 200 kw, with a range of frequencies for all but the most unusual needs. For added information, write for Descriptive Data 85-800. Or, for aid on any specific application, ask a Westinghouse engineer to call. Write Westinghouse Electric & Manufacturing Co., P.O. Box 868, Pittsburgh 30, Pa. J-08098

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

TORRINGTON BEARINGS HELP INCREASE DRILLING SPEEDS



Torrington Angular Contact Bearing designed for rotary tables which carry the load of the drilling "string" in drilling oil wells.

Increasing demands for faster oil production call for equipment that can take it. To increase service life and minimize maintenance in the rotary tables that control oil well drilling speeds, engineers specify the use of Torrington Angular Contact Bearings. Especially designed to carry both the radial and thrust loads imposed by high speed drilling, these modern anti-friction bearings are rigidly controlled in the hardening and grinding process to insure utmost precision and equalize load distribution under all service conditions.

Solving new or unusual bearing problems of the oil, steel, paper, machine tool and other specialized applications is all part of the day's work for the engineers of Torrington's Bantam Bearings Division. Profit by their diversified knowledge and experience by specifying Torrington Bearings when you order equipment.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

COMPRESSORS TO SCORCH PILL BOXES

THE SAME "KNOW HOW" MAY HELP YOU FIRE THE "BUGS" OUT OF THAT POST-WAR DESIGN.
Planning to build a compressor into that post-war design? Faced with problems of weight—space—cooling under adverse conditions? Need absolute reliability? Write us. We keep strict confidence.

When the nation called for portable flame-throwing units...to burn Japs out of jungles, or scorch the life out of deadly pill boxes . . . Worthington designed a nitrogen compressor to provide the motive power that sweeps the flame to its target.

It had to be *light, air-cooled, compact,* yet *powerful* and rugged enough to stand the rigors of war. Above all, it had to be *reliable.*

In addition to these 2000 lb. nitrogen compressors for flame-throwers . . . Worthington has designed and built engine-starting compressors for landing craft . . . compressors for air field service trailers . . . for high altitude aircraft oxygen-generating units.

Each involved a design problem. In each case, *the compressors could not fail!*

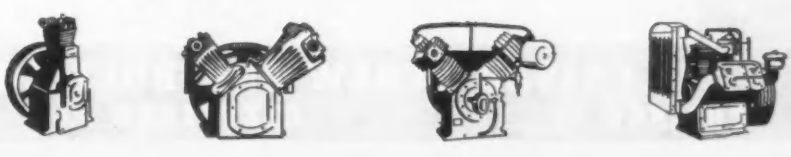
Worthington is still building vertical compressors for war. Soon, we hope, this war-sharpened Worthington skill with all the variables of compressor design . . . this Worthington dependability, chosen above all to meet the exacting demands of war production . . . will be at *your* service . . . to help you solve your design problems . . . or provide for your plant the best standard vertical compressors money can buy. *Worthington Pump and Machinery Corporation, Harrison, N. J.*

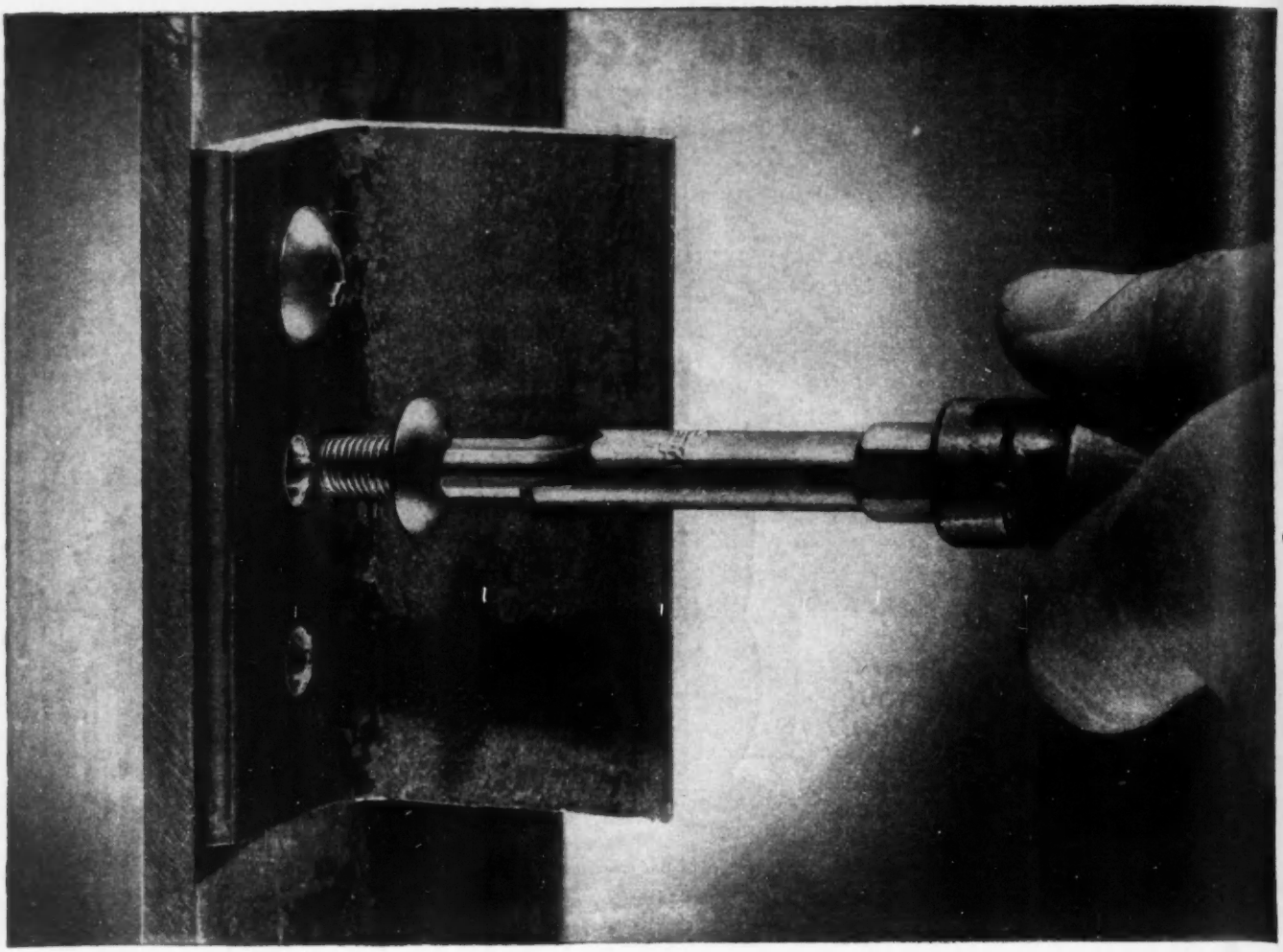
AC 4-17

BEHIND THE NAME
WORTHINGTON

STANDARD PRODUCTS DIVISION

VERTICAL AND RADIAL COMPRESSORS —ONLY PART OF WORTHINGTON'S STANDARD PRODUCTS LINE



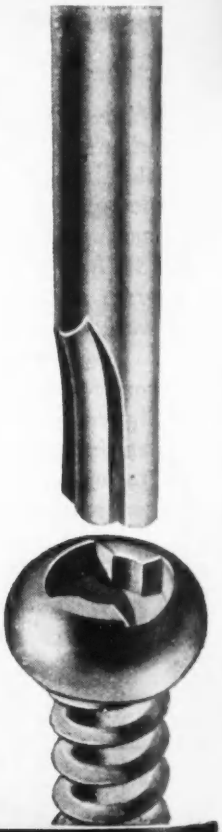


There Is No Tougher Test in assembly than the driving of thread-forming screws; especially where the thickness of the metal equals or exceeds the diameter of the screw. This is the critical spot where CLUTCH HEAD'S special features, *of both screw and driver,* challenge point by point comparison... for lower cost, efficiency, speed, and safety.

- ✓ Rugged Type "A" Bit construction for longer uninterrupted service and longer total life, plus simplified reconditioning, means fractional tool maintenance and assembling costs.
- ✓ Automatic dead-center entry with the Center Pivot for the speed and certainty of *straight* driving.
- ✓ Square instead of "tapered" engagement . . . a *straight*-sided driver contacting *straight*-walled Clutch recess . . . eliminates ride-out and reduces end pressure to a minimum.
- ✓ Positive engagement for definite torque drive; no chewed-up heads; no hazard of slippage to injure manpower or damage materials.
- ✓ The CLUTCH HEAD Lock-On which carries screw and bit as a unit for fast one-motion driving.
- ✓ And . . . an ordinary type screwdriver will service CLUTCH HEADS.

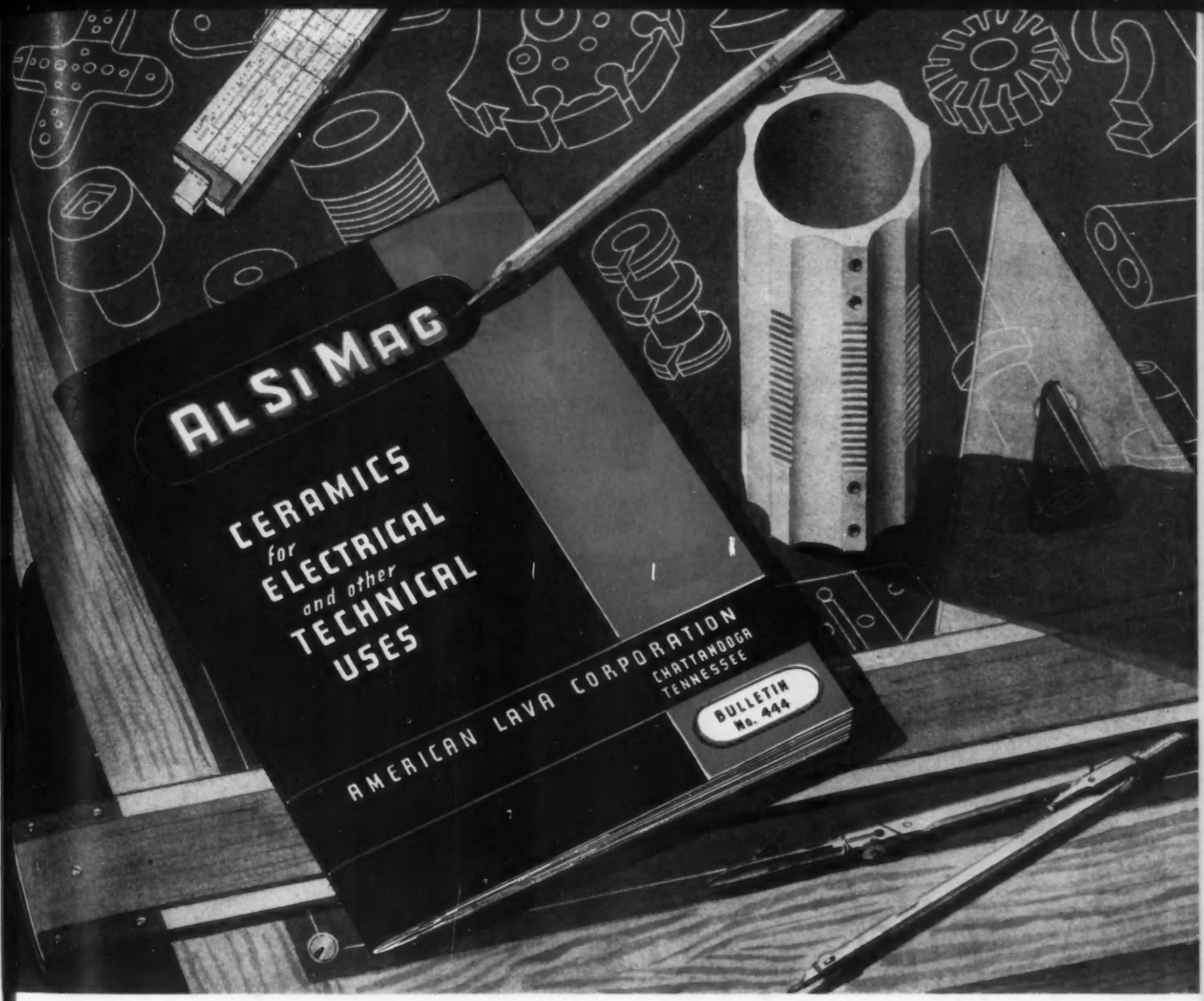
You are invited to make your own test of these and other exclusive advantages by asking us to mail you package assortment of CLUTCH HEAD *Screws, sample TYPE "A" Bit and fully illustrated brochure.*

CLUTCH HEAD · SCREWS ·



UNITED SCREW AND BOLT CORPORATION

CHICAGO 8 CLEVELAND 2 NEW YORK 7



ANNOUNCING BULLETIN NO. 444

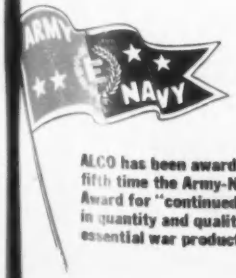
... JUST OFF THE PRESS

BULLETIN No. 444 will prove a valuable tool in the hands of Engineers, Designers and Research Men. It is also a helpful, informative guide for Purchasing Agents.

ALSIMAG Ceramic Insulator bodies, each with its particular physical and electrical characteristics, are concisely described and the uses indicated.

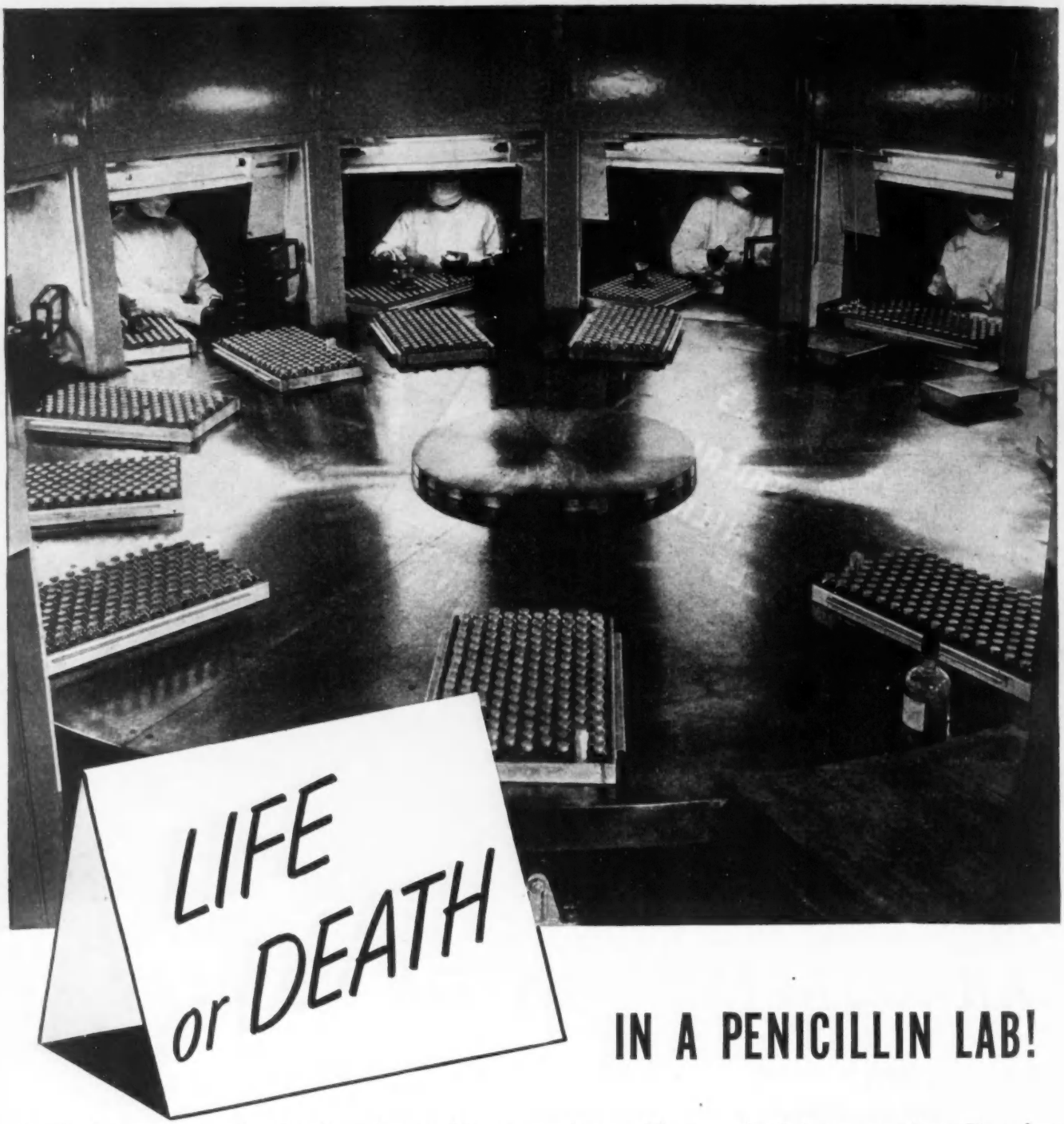
Typical designs taken from a roster of more than 25,000 distinct items are splendidly illustrated—in groups of applications covering electrical, electronic, industrial heating, chemical, automotive and other fields. Property charts and other technical data, together with practical information on manufacturing processes, are included.

Here is valuable, authentic information... the latest work on Ceramic insulators... in concise, easy-to-use form. If you have not received your complimentary copy of Bulletin No. 444, please write for it today.



ALCO has been awarded for the fifth time the Army-Navy "E" Award for "continued excellence in quantity and quality of essential war production."

AMERICAN LAVA CORPORATION
CHATTANOOGA 5, TENNESSEE



IN A PENICILLIN LAB!

This is the stage-setting for the climactic moment in a penicillin laboratory. White-robed, rubber-gloved and masked technicians work swiftly at a turntable. They are capping sterilized vials containing powder refined from this magic new life-saving mold.

Germs on the loose here might mean the difference between life and death for thousands of hopeful patients. Every precaution is taken. One of these is the turntable, made of ARMCO Stainless Steel. This rustless steel is easy to clean and keep clean. The dense, smooth, polished surface won't let harmful bacteria get a toe-hold. And there is no danger of rust particles forming on the surface.

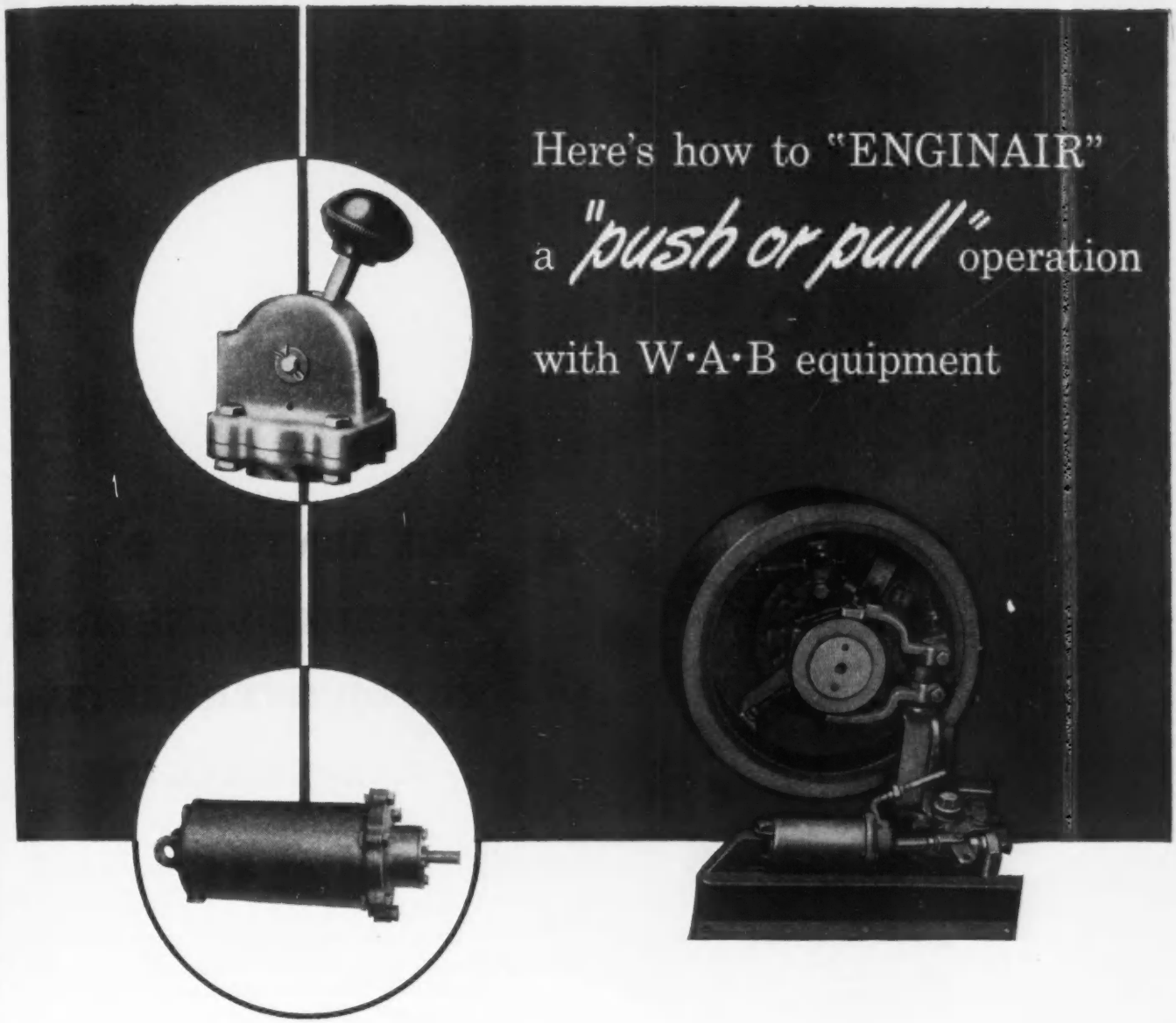
Like many manufacturers in the food and drug industries, this maker of penicillin selected stainless steel for important processing equipment. It measured up to all requirements—and more.

There is a good chance you can profit by using ARMCO Stainless Steels in your products. If you have something in mind, we'd like to discuss the possibilities with you. Just write to The American Rolling Mill Company, 291 Curtis St., Middletown, Ohio.

EXPORT: THE ARMCO INTERNATIONAL CORPORATION

STAINLESS ARMCO STEEL

THE AMERICAN ROLLING MILL COMPANY



The whole history of industrial development has been the substitution of horse-power for muscle-power in production jobs. W·A·B devices let you apply the same sound principle to *control* jobs, too.

In the countless control applications where only a simple push or pull is involved, the two W·A·B devices pictured, plus a source of compressed air, are all you need to do the trick. Movement of the control handle—you can shift it with a finger-tip—produces immediate responsive movement of the piston in the air cylinder. Any desired actuating force, from ounces to tons, can be designed into the system. The control valve and piston may be separated by any distance, and connected by an air line. In cases where the actuating equipment is mounted on a mobile part this line can be flexible. A battery of control valves, to govern any number of functions, can be concentrated on one small stand. The complications, adjustments, and maintenance of mechanical linkages are minimized or eliminated.

The illustration at right shows a simple "push-pull" system applied to a clutch—only one of many possible applications. If you have any control problem in your present or contemplated production equipment or products, "Enginairing" (which is engineering applied to air) can probably solve it better. You'll find proven W·A·B devices available to do the simplest and the most complicated jobs. Ask for Tite-Air Valve descriptive circular No. 1DA-9431-1.

WESTINGHOUSE AIR BRAKE COMPANY

INDUSTRIAL DIVISION

General Offices:
WILMERDING, PA.

WABCO PACKING

COMPRESSORS

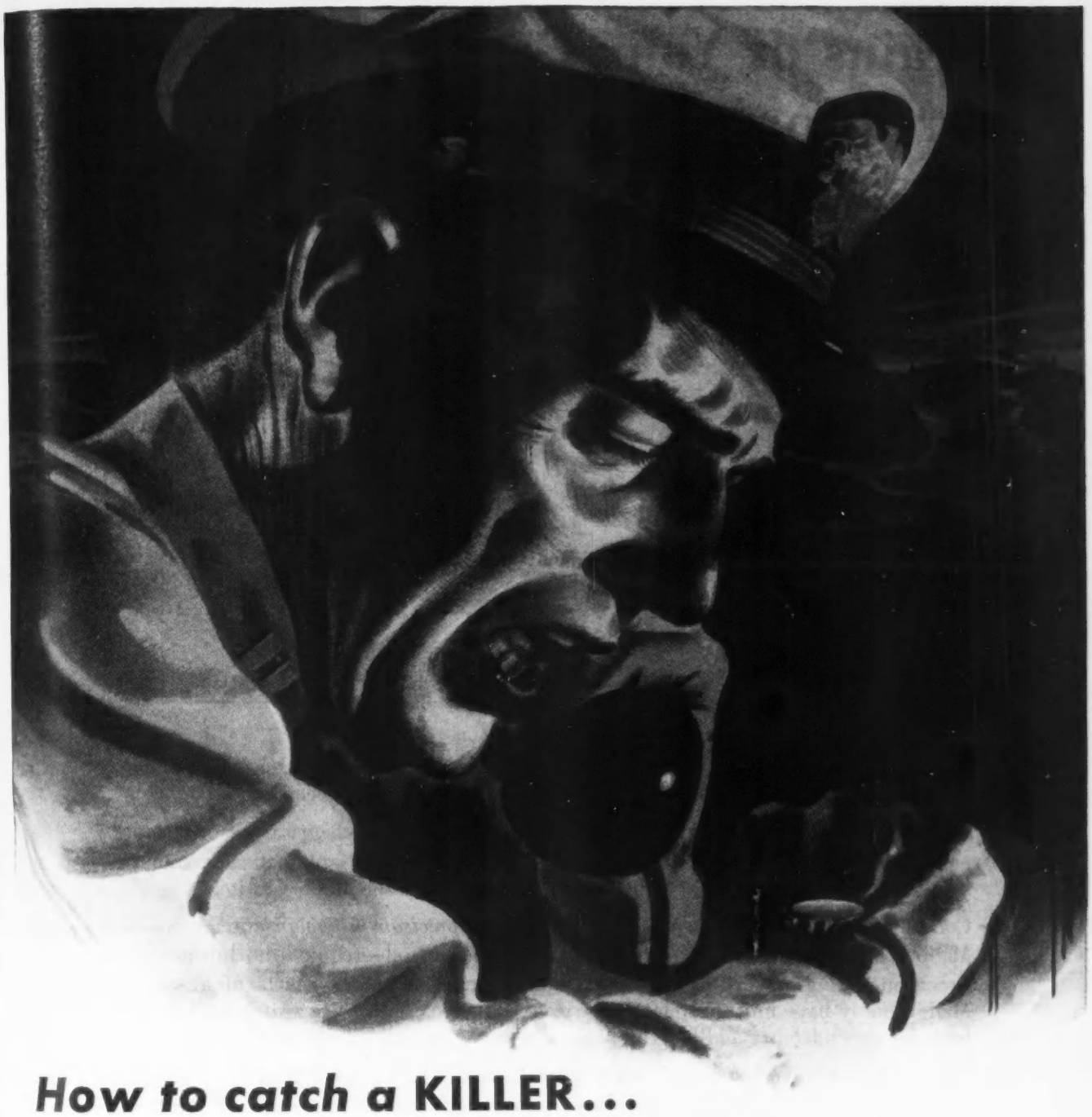
REMOTE CONTROLS

THIS SENTRY PREVENTS DANGEROUS MOTOR OVERHEATING AND BURNOUTS

If you want to be assured of full motor life from your motors, specify Built-in Klixon Protectors... the silent sentries that guard against motor overheating and possible burnouts, yet never interfere with the maximum safe operating capacity of the motors. Built into the motor by the motor manufacturer, Klixon Protectors provide accurate overheat protection. When the motor becomes overheated and dangerously hot, the Protector snaps the power "off". Then when the motor cools to a safe operating temperature, it snaps the power "on" again, either by manual or automatic reset depending on the type of protector you specify. Klixon protection is good for the life of the motor. The actuating disc outlasts the life of the motor...starting and stopping the motor year after year whenever it becomes overheated. Stop production delays, motor repairs and replacements caused by motor burnouts. Specify Klixon Protectors with every motor you buy. They are available with A. C. motors all sizes; D. C. motors up to 30 volts.

KLIXON MOTOR PROTECTORS

SPENCER THERMOSTAT CO., ATTLEBORO, MASSACHUSETTS



How to catch a KILLER...

day after tomorrow, at exactly 2120 hours

When an enemy raider is located hundreds of miles away, a course is laid to intercept it at a certain time, at a definite point on the map. Then having once spotted the enemy, Navy navigators keep a "running fix" on him. At the same time, they fix their own position . . . in relation to his . . . by allowing for wind and drift, *and by counting every turn of their ship's propellers*, as the turns are recorded by revolution-counting devices geared to the propeller-shafts.

These counting devices are mounted both in the wheelhouse, and on the engine-room gauge boards. And they are part of the equipment of every Naval and merchant ship . . . because they supply the basic data in the dead-reckoning of a ship's position by showing the number of shaft-revolutions made (which means distance travelled) in any given length of time. Many of these devices are made here, in The Counting House of Industry . . . made with the knowledge that on their accuracy lives, battles, and cargoes may well depend.

The Counting House of Industry

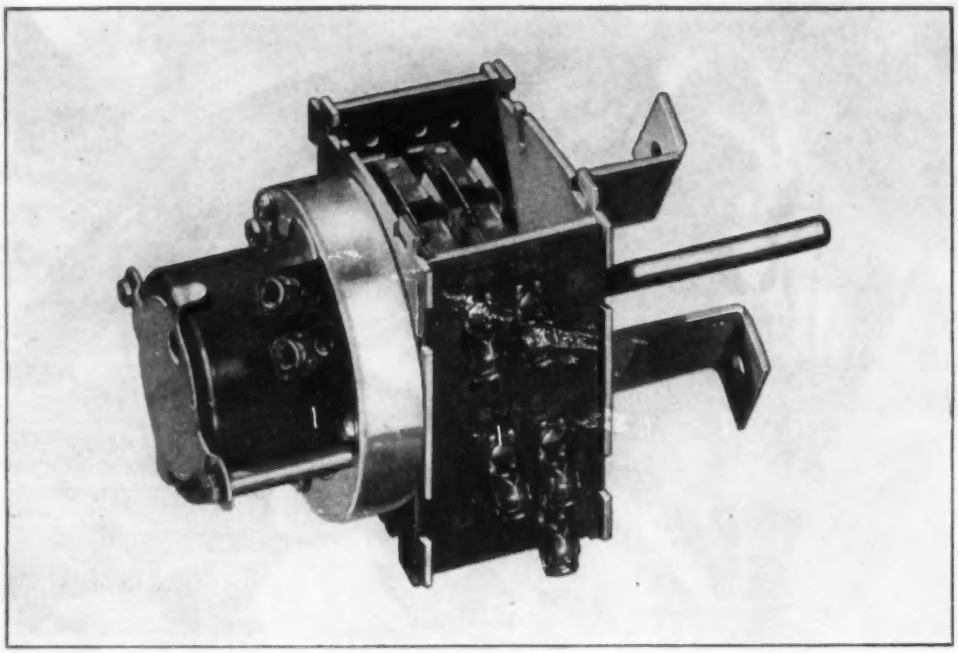
VEEDER-ROOT INC.

Hartford 2, Connecticut

In Canada: Veeder-Root of Canada, Ltd., Montreal
In England: Veeder-Root Ltd. (new address on request)

★ The Armed Forces Count on You to BUY BONDS! ★

Brains of Your Postwar Product– a Mallory Interval Time Switch



HERE'S a precision part—developed by Mallory for controlling automatic home laundry equipment, washing machines and dryers—that seems almost human.

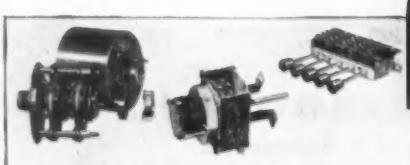
Controlled by a Mallory Interval Time Switch, a piece of electrical or electronic equipment performs a pre-determined sequence of operations automatically. Simply set a dial, and the machine's "thinking" is done for it by the Mallory switch.

Construction of the time switch is typical of the *precision workmanship* for which Mallory is noted. The small sturdy motor is sealed in oil—requires no lubrication. Precision springs assure smooth mechanical operation, and contacts of a special Mallory alloy have uniformly low electrical resistance. The entire switch is ruggedly built for dependability and long life.

Manufacturers of industrial, electrical and electronic equipment . . . seeking greater operating efficiency and output . . . will find many uses for the Mallory Interval Time Switch, as have makers of household appliances. The postwar trend to automatic operation is evident.

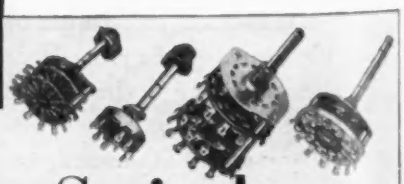
Now is the time to discover how *you* can incorporate the "brains" of this switch in your postwar products—for the greater efficiency that assures greater sales appeal. Consult Mallory while your designs are being planned.

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



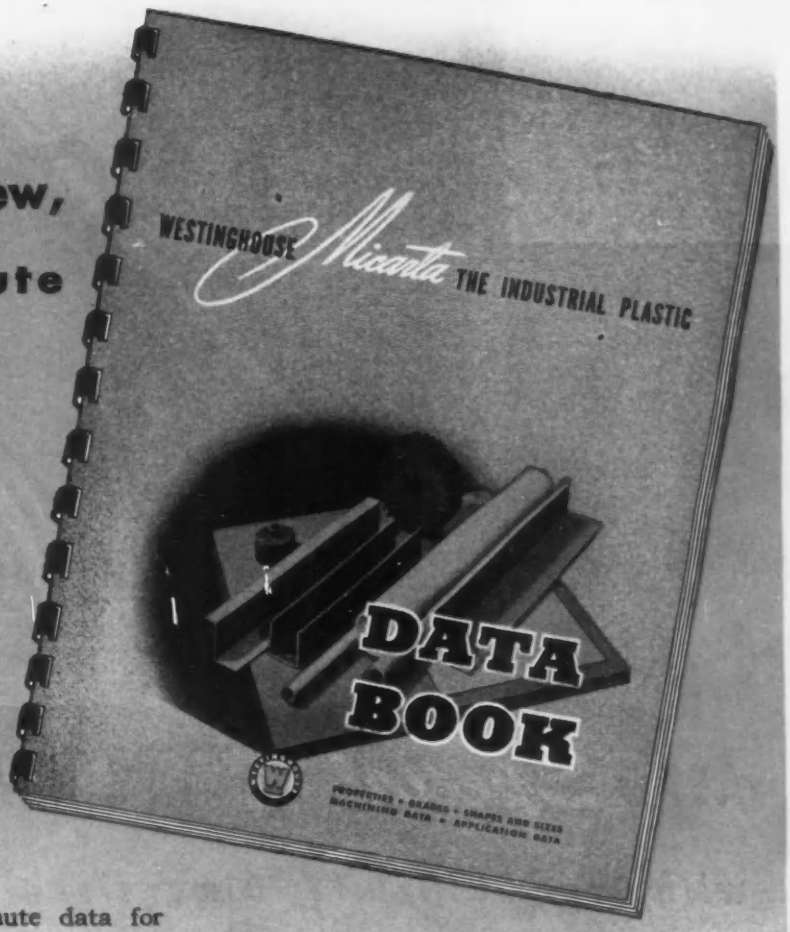
P. R. MALLORY & CO. Inc.

MALLORY



Industrial and Electronic Switches

40 pages of new, up-to-the-minute *facts* FOR USERS OF INDUSTRIAL PLASTICS



Here's new and up-to-the-minute data for designers, in concise, easy-to-use form. Users of industrial plastics . . . manufacturers looking for ways to utilize the advantages of Micarta to replace other materials . . . will find full and helpful information in this revised and enlarged Micarta Data Book.

Forty pages of property tables, performance curves and design suggestions provide working data for selecting the proper grade of Micarta for heavy-duty service in any field. Data covers both laminated, molded, and formed Micarta. Grades include those designed for severest wear, and for applications requiring electrical and chemical properties.

Reserve your copy of the new Micarta Data Book today. Write Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N. J-06354-1

GET THIS HELPFUL DATA:

Grades of Micarta—their characteristics . . . corresponding Army and Navy types.

Properties of Micarta—mechanical . . . electrical . . . chemical . . . how they compare with other materials.

Designing Help—machining data . . . how to apply directional loads . . . molded and formed Micarta design suggestions.

Forms Available—standard shapes and sizes . . . plates, rods, tubes, angles, channels, zees.

Westinghouse **Micarta**

PLANTS IN 25 CITIES . . . WESTINGHOUSE OFFICES EVERYWHERE

AERO *Special* AN-442 RIVET SETS

with Cups COINED for Dimensional Accuracy

Hard-to-work flat head rivets are easily driven with one hand when the new *engineered* Aero special tool is used. Cups coined to assure uniform dimensional accuracy with a maximum radius of only .010."

Danger of rejects caused by improperly fitting turned tools is eliminated. The new Aero set will not flatten, distort or otherwise weaken flat head rivets, allowing for positive maintenance of rigid engineering standards.

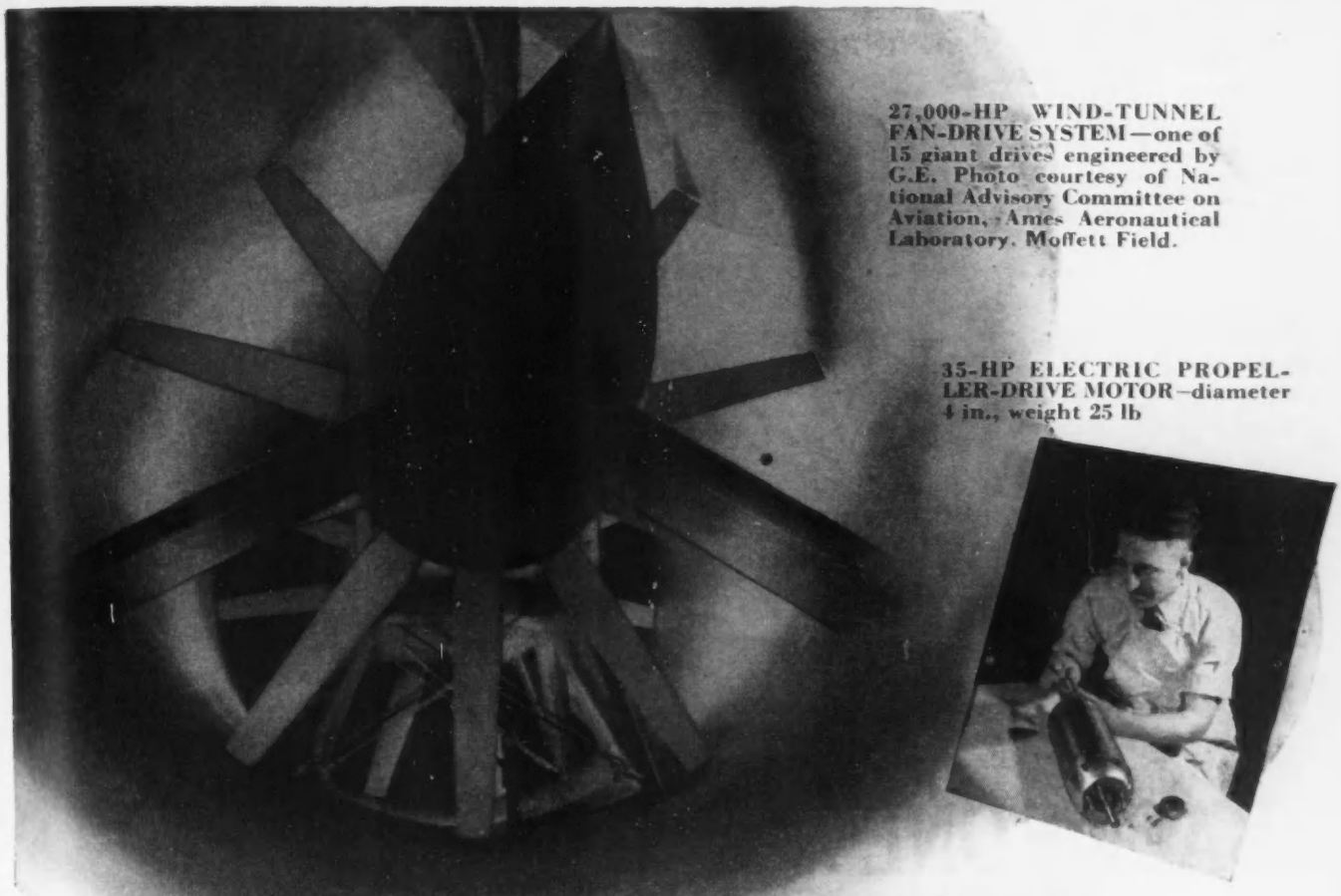
Plants using flush sets to drive AN-442 rivets may substantially increase production and eliminate rejections caused by skin abrasions due to slippage of flush sets. Cost per rivet driven will go down and the strength of the rivet joint will not be impaired when the Aero tool is substituted for incorrect flush sets.

Write now on firm letterhead for full engineering information on the performance of these new rivet sets . . . ask for Catalogue Page No. 1A.

Coined AN-442 sets are available in both straight and offset at no increase in catalogue prices. Order by number shown above, specifying AN-442 cup in size and length desired.

AERO TOOL CO.

BURBANK · CALIFORNIA



27,000-HP WIND-TUNNEL FAN-DRIVE SYSTEM—one of 15 giant drives engineered by G.E. Photo courtesy of National Advisory Committee on Aviation, Ames Aeronautical Laboratory, Moffett Field.

35-HP ELECTRIC PROPELLER-DRIVE MOTOR—diameter 4 in., weight 25 lb

HORSEPOWER

for "Hurricane Times 8"

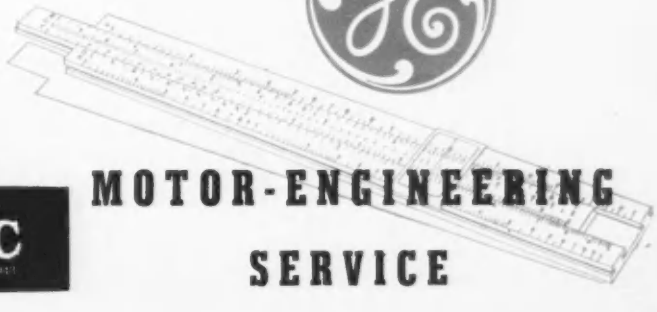
Two related, yet strikingly different G-E special motor designs are now helping to extend the range of wind-tunnel research:

To deliver 600-mph wind for a tunnel of exceptional size, G.E. developed a propeller drive incorporating two 15,000-hp wound-rotor motors (327 rpm). This drive provides 800 steps of speed, and can hold each speed constant within ¼ of 1 per cent despite load changes. This drive also makes possible the recovery of power which is usually lost when wound-rotor motors are operating at reduced speeds. This power is returned to the line.

Second, several electric propeller motors have been developed for use as "engines" on model planes in wind-tunnel research. One of these is a water-cooled motor which develops 35 hp at 18,000 rpm. It has an outside diameter of only 4 inches and is just 10 inches long. Its weight, 25 pounds, is approximately 4 per cent of the weight of an 1800-rpm, 35-hp electric motor of conventional design. Among other G-E motors for this service is one rated 200 hp (5000 rpm) and weighing but 525 pounds; another (200 hp) operates at 20,000 rpm!

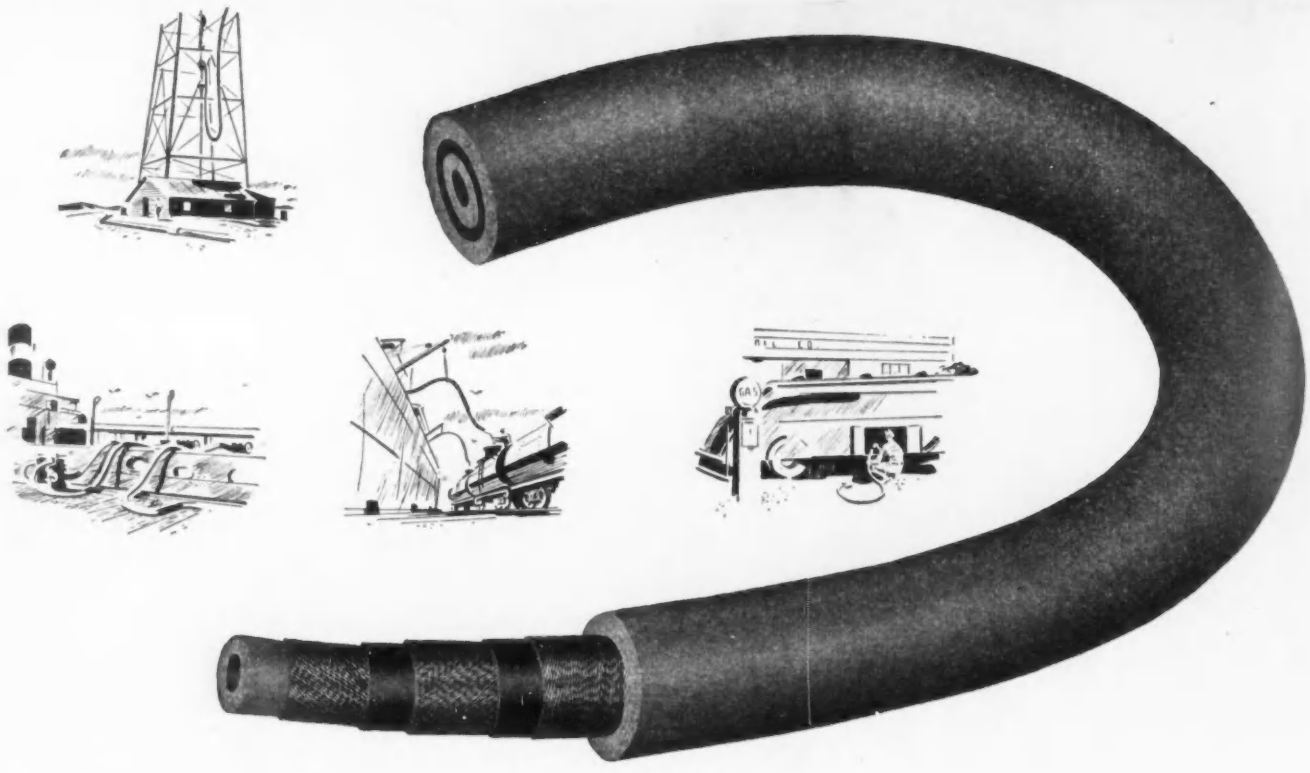
No matter how your motor problem differs from these, the same experience which created these "firsts" in special motors is on tap, should your job require it. If one of General Electric's standard motors cannot be adapted to your particular task, our motor engineering service will work with you in developing a new drive to solve your problem. War needs come first, but our broad facilities may permit us to work on your job sooner than you think. Before you apply a motor to *any* new machine—check with your local G-E representative. *General Electric Company, Schenectady 5, New York.*

Buy all the BONDS you can
—and keep all you buy



GENERAL ELECTRIC

MOTOR-ENGINEERING SERVICE



BACKBONE...
For a High Pressure Hose

OIL well rotary drilling hose has to take pressures up to 5,000 pounds, stand up under constant flexing and re-flexing, carry heavy volumes of fast-flowing mud to lubricate the drilling. It takes plenty of *backbone* to hold up under that kind of strain, and so in this hose, as in many other types, the backbone is steel wire.

Only the highest quality steel *wire* can provide the necessary reinforcement for strength and long life . . . its use in fabricated form helps provide the highest degree of flexibility necessary for this rugged service.

That's why most leading hose manufacturers have consistently specified braided *steel wire* especially developed with essential characteristics for hose reinforcement.

Developing and producing that kind of wire has been National-Standard's main job since the early days of the rubber industry. Close cooperation between rubber engineers and National-Standard wire experts has resulted in uniform high quality wire for many types of hose, brought forth time-saving, cost-reducing machinery for the application of wire into finished products, and has lead to many *new* uses for wire with rubber. Tires, airplane de-icers, conveyor belts, V-belts, and tubing are only the beginning of even greater wire-and-rubber developments to come.

If you have plans for product improvement or development, let National-Standard's experience help with a type of wire and method of application specifically fitted to your product.

BUY AND KEEP WAR BONDS

NS
NATIONAL-STANDARD Company
NILES · MICHIGAN

Divisions of National-Standard Company

NATIONAL-STANDARD
Niles, Mich.
TIRE WIRE, FABRICATED BRAIDS AND TAPE

ATHENIA STEEL
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WAGNER LITHO MACHINERY
Hoboken, N. J.
LITHOGRAPHING AND SPECIAL MACHINERY

WORCESTER WIRE WORKS
Worcester, Mass.
ROUND STEEL WIRE, SMALL SIZES

A leaf actuator makes this Switchette into a tiny limit switch.
The G-E Switchette
Selector switches made up of Switchettes provide compact, sequence circuit control.
In this compact multicircuit switch, Switchettes save space and weight.
This small but sturdy limit switch has widespread application. The Switchette is actuated by a plunger.

KEY TO COMPACT DESIGN

YOU can use Switchettes to control several circuits from a single location. They can be actuated by cams in selector switches, or by a bellows or lever in limit switches. Whichever way you use them, G-E Switchettes help you save space and make your equipment more compact.

Note the dimensions: 1¼ by ½ by ½ inch. Yet the Switchette handles up to 10 amperes at 24 volts d-c (230 volts a-c), and is sturdy enough to withstand millions of mechanical operations.

Its small size, its lightning-fast snap action, and its ability to resist high physical shock and vibration make it ideal for built-in applications on electric control equipment that has to "take it." Best of all, because of its unusual double-break contact structure, it simplifies the solution of many tricky circuit-control problems.

Don't handicap your important designs

Your plans for a smaller, lighter, or more compact equipment need not be stymied by the lack of a suitable make-and-break contact mechanism. More than 200 modifications of the Switchette are ready to meet your needs. In addition, we have a variety of limit switches, transfer and selector switches, push-button stations, thermostats and timers built around the Switchette. Perhaps you can use some of these ready-made devices to advantage.

Send for a catalog

If you don't already have a copy of our Switchette catalog, mail the coupon below. If none of the forms listed in the catalog meet your needs, our engineers will be glad to work with you to adapt them. *General Electric Co., Schenectady 5, New York.*

General Electric Company, Section D670-142
Schenectady 5, New York

Please send me Bulletin GEA-3818, which gives detailed information on Switchettes.

NAME .....

COMPANY .....

ADDRESS .....

.....

8940

GENERAL ELECTRIC

BUY WAR BONDS

THE FOG THAT BLOTS OUT FIRE

OFFICIAL U.S. NAVY PHOTOGRAPH

...starts here

WaterFOG . . . the *new* fire-fighter . . . is especially valuable in choking off the concentrated fires met aboard ship. Even oil fires and fires around electrical apparatus can now be extinguished with water.

WaterFOG equipment, made under patents of the Rockwood Sprinkler Company, Worcester, Mass., has helped save tankers, warships and transports . . . and the men aboard them.

In WaterFOG nozzles, tiny openings are so paired that streams of water impinge and shatter into mist. The resulting fog chills down the heat, cuts off the fire's "breath" and quickly smothers the flame.

Screening out dirt, seaweed and other matter which might plug up the tiny nozzle holes is essential. This is done by strainers . . . one at the hydrant or water pump, the other in the nozzle itself.

After investigating the metals and alloys which could be used to make these strainers, Rockwood selected Monel to solve these three problems . . .

1. **Strength and Hardness to Withstand a Working Pressure of 175 psi.** In tests the thin-gauge Monel strainers have resisted the erosive and abrasive action of water and solid particles blasting against them at pressures up to 600 psi.

2. **Resistance to corrosive attack.** Since any convenient source of water can be used for WaterFOG, the strainers must be able to withstand corrosion by any waters, fresh, salt or polluted.

3. **Ready Workabilty.** To make sure that all dirt particles big enough to give possible trouble are removed, the openings in the strainer must be a good deal smaller than the 1/16" openings in the nozzle. The sheet from which the strainers are made must be thinner, in turn, than the diameter of the strainer openings (to prevent breakage of the punching dies.) And the photograph shows why the forming of the strainers requires a ductile material which can be readily shaped and joined by either soldering or welding.

Their choice of Monel has been confirmed by the service records of these strainers. Every Monel strainer in all the Rockwood WaterFOG installations in ships at sea and industrial power plants ashore is still giving perfect service.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.

MARINE FIRE PLUG STRAINER *with Monel strainer, made by Rockwood Sprinkler Co. Quick Flushing type, approved by the Bureau of Ships, U.S. Coast Guard and Maritime Commission.*

Upper figure shows nozzle with Monel screen used in WaterFOG equipment for fixed installations. Fine-gauge strainer withstands 600 psi . . . high temperatures . . . severe corrosive attack.

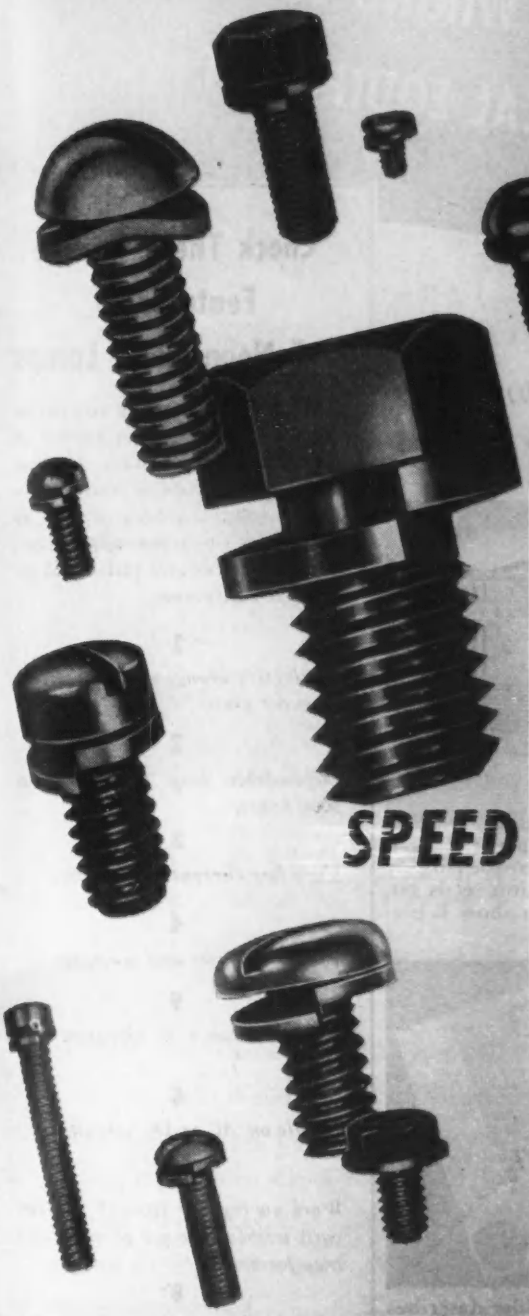
MONEL

NICKEL (INCO) ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL • *Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas & Electric)*

THIS JOB COMES 4/5 DONE

EATON *Springtites* SAVE ALL BUT ONE



The usual cycle of a screw and washer fastening job involves at least five hand motions. There's "pick 'em up" with two motions. And "put 'em on" is two more. Plus the application makes five. Eaton Springtites cut this cycle down to one smooth quick motion . . . "pick 'em up and apply". That's why a Springtite assembly job is well nigh done before you even touch it.

SPEED PRODUCTION *with Springtites*

Pre-assembled screw and washer units bring new efficiency to straight line production. Eaton Springtites save time and money by reducing costly, unnecessary hand motion—provide an automatic balance of inventory—a single container for bench stock—and eliminate loss of Spring Lock Washers to the sweeper.

Eaton Springtites are engineered for correct design of Spring Lock Washer fit under the screw head—it can't come off. Springtites provide adequate automatic Spring Lock Washer tension to compensate for looseness as a result of wear.

DESIGNERS AND ENGINEERS ATTENTION: Write for Folder No. 101 and see how 4/5 of your fastening problem can be eliminated.

Reliance Spring Lock Washers — for every purpose — automatically keep bolts, nuts, screws tight and under constant tension, compensating for inevitable wear and developed looseness. Write for Spring Lock Washer Folder No. 142.

Reliance snap, bearing, lock, retainer rings are used on shafts, in counter bores, and on outer races of bearings. Cut production cost by saving time and material. Write for Engineering Folder No. 43.

EATON

MANUFACTURING COMPANY

RELIANCE DIVISION

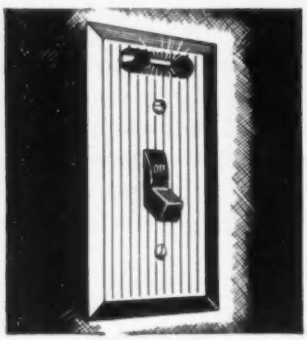
DEPT. E, MASSILLON, OHIO

QUICK VISUAL INDICATORS

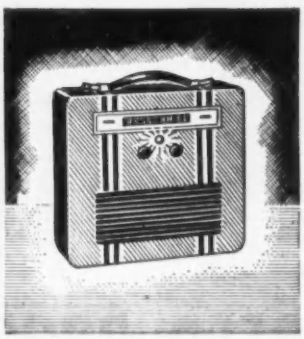
FOR HOME APPLIANCES . . . WIRING DEVICES . . . INDUSTRIAL ELECTRICAL EQUIPMENT

Build more Sales Appeal into your postwar products with applications of G-E Glow Lamps like these:

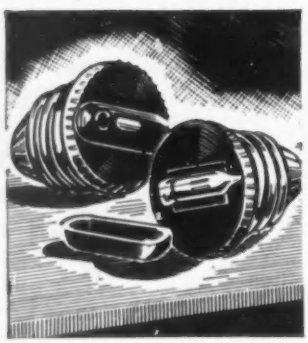
G-E GLOW LAMP gives instant visual indication iron is "on." Other applications: waffle irons, ranges, roasters, heating pads.



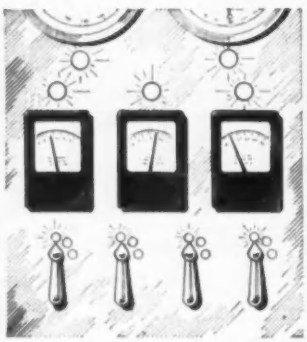
NO FUMBLING IN DARK to find light switch if it has G-E Glow Lamp as indicator. Lamp is visible guide to location of switch.



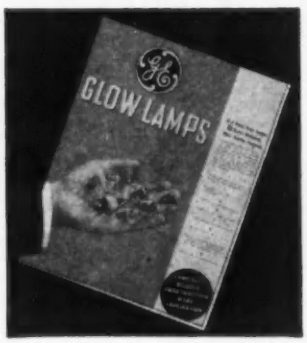
IN PORTABLE RADIO SETS. G-E Glow Lamp provides highly visible indication set is on. Also usable to show B-battery condition.



G-E GLOW LAMP makes it easy to find burned-out fuse. Lamp is wired to light when fuse burns out.



DEPENDABILITY AND LONG LIFE recommend G-E Glow Lamps as panelboard indicators to show circuit conditions.



FREE! New folder describes typical uses for G-E Neon Glow Lamps and gives lamp data. Write address below.

Check These Unique Features of G-E Neon Glow Lamps

G-E NEON GLOW LAMPS can add to the convenience and sales appeal of your postwar products! Unique characteristics of G-E Neon Glow Lamps suggest scores of uses as indicators on home appliances, wiring devices and industrial electrical equipment.

1

Distinctive orange red glow, needs no cover glass.

2

Dependable long life—rated at 3000 hours.

3

Very low current consumption.

4

Variety of sizes and wattages.

5

High resistance to vibration and shock.

6

Usable on AC or DC circuits.

7

Work on regular 105-125 volt circuits without the use of step-down transf rs.

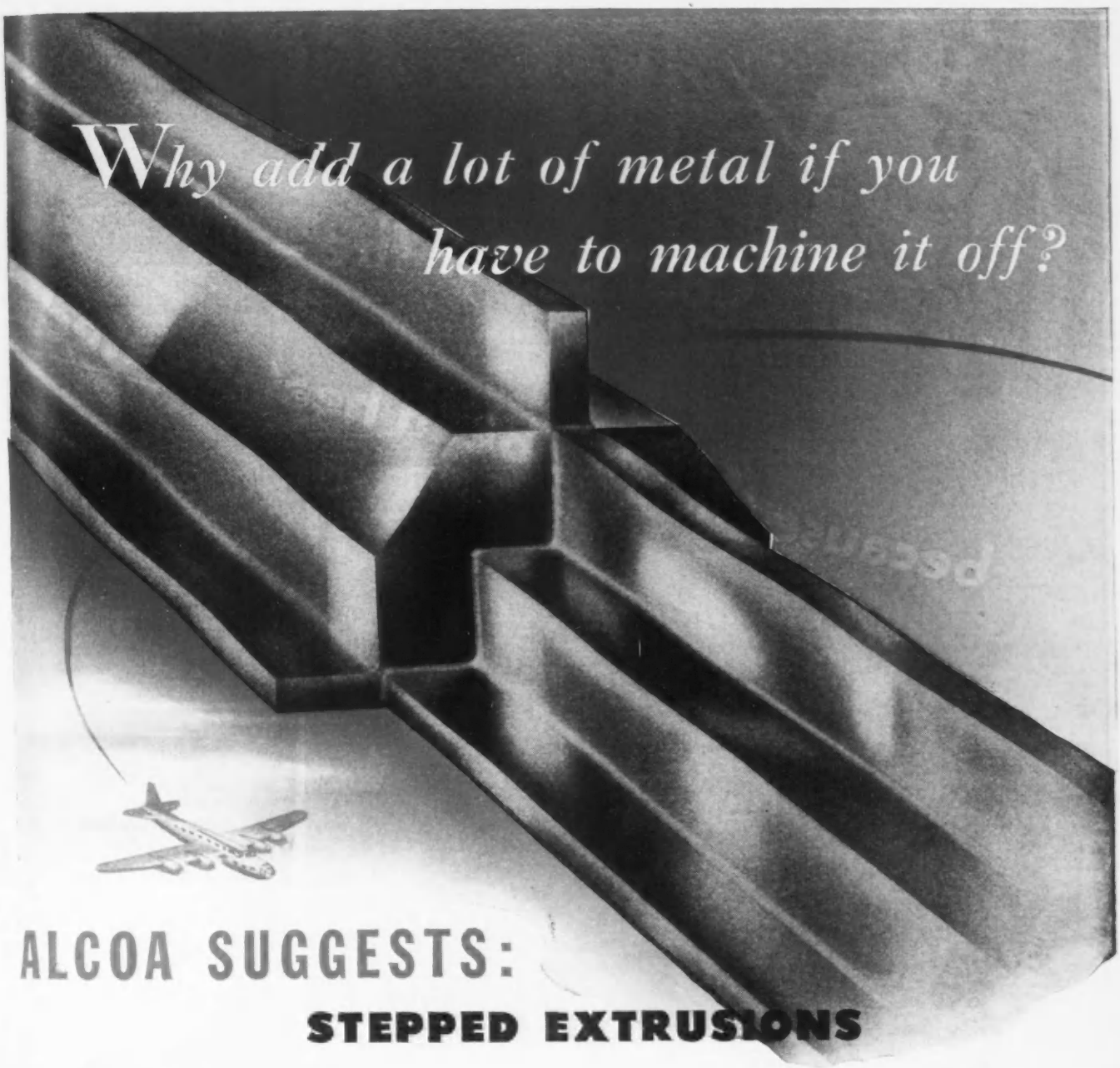
8

Practically no heat.

NELA SPECIALTY DIVISION LAMP DEPARTMENT

GENERAL ELECTRIC

1 Newark St., Hoboken, N.J.



Airplane wing spar caps call for tapers consistent with strength requirements. Reducing straight sections to a taper requires expensive, time-consuming machining. Alcoa's stepped extrusions can be used to reduce the amount of metal to be removed to produce a taper. Production is speeded up, costs reduced.

Stepped extrusions can provide a larger, integral section from which the attachment fitting is cut out. This avoids the extra weight and cost of a splice.

Will stepped extrusions fit your production? Each case must be analyzed individually from a design and an economic standpoint. Alcoa engineers will gladly give you the benefit of their experience to determine the facts. ALUMINUM COMPANY OF AMERICA, 2193 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN ALUMINUM

The best trained troops require tempering under fire to become seasoned fighters. Springs, too, need proper tempering to fit them for the rigorous demands of tough fighting mechanisms. Because heat-treatment is so vital to spring performance, its selection and control come within the realm of our laboratory technicians, with automatic regulation that insures parade-ground precision—precise action—long service. No guesswork—Barnes-made Springs are under strict discipline in *every* stage of manufacture. They obey *your* orders.

CONSERVE METAL—DESIGN WISELY

1918–THEN AND NOW

ARMY E NAVY

Barnes-made Springs

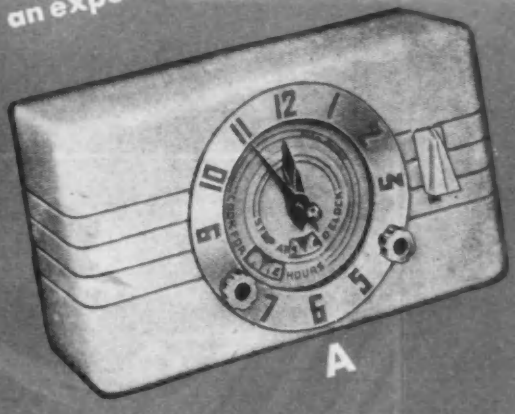
ENGINEERED PEP AND POWER

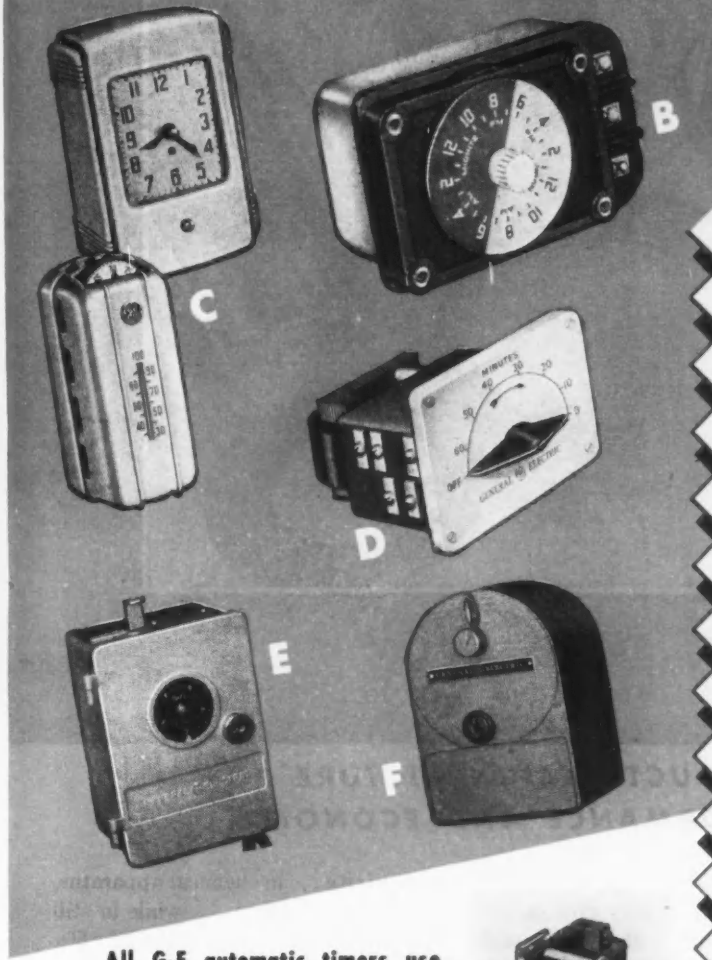
WALLACE BARNES COMPANY DIVISION OF ASSOCIATED SPRING CORPORATION BRISTOL, CONNECTICUT, U. S. A.

AUTOMATIC TIMERS

that will help sell appliances

Choose simple, dependable, proved-quality timers designed by an experienced timer manufacturer





For ELECTRIC RANGES A

Select the G-E range timer, built-in (mechanism only) or completely cased (illustrated).

For REFRIGERATORS B

Select the G-E defrost clock (built-in model illustrated), which automatically defrosts every 24 hours.

For OIL BURNERS or STOKERS C

Select the G-E day-night timer, with or without stoker, hold-fire contacts, and the G-E thermostat.

For CLOTHES DRYERS D

Select the G-E clothes-dryer timer (built-in model illustrated)—sequential cut-off protects fabrics.

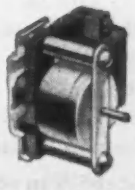
For COLLECTION "METERS" E

Select this G-E coin-operated timer for easy collection of installment sales.

For APPLIANCE RENTALS F

Select this G-E coin-operated timer for apartment-house washing machines, hotel radios, etc.

All G-E automatic timers use exclusively the well-known Telechron motor—the heart of the timer.



For prompt delivery (following WPB release) order NOW from our nearest office, or write General Electric Co., Schenectady 5, N. Y.

Buy all the BONDS you can—and keep all you buy

GENERAL ELECTRIC

General Plate Laminated Metal

FITS INTO YOUR PRODUCT DESIGN PICTURE FOR VERSATILITY, PERFORMANCE AND ECONOMY

The simplest and surest way to *get a head start on post-war competition* is to plan and design your peace products now. And during these design stages is the time to consider and investigate the use of General Plate Laminated Metals.

These permanently bonded laminations of precious metals to base metals or base to base metals combinations fit into your design picture whether you are planning electronic devices, electrical products, signal control apparatus, instruments or electrical contacts. Their versatility, performance and economy provide many advantages *not* found in solid metals. For instance, in electrical products, they provide better conductivity . . . in chemical apparatus, they give maximum corrosion resistance . . . while in still other products they insure better performance and long life. General Plate Laminated Metals are available in sheet, wire and tube form . . . inlaid or wholly covered. Many new laminated combinations developed since the war are also now available.

Establish an advance position for your post-war products—incorporate General Plate Laminated Metals into your products now! Our engineers are available for consultation on your problems. Write for their services.

GENERAL PLATE DIVISION

OF METALS & CONTROLS CORPORATION

50 Church St., New York, N. Y. • 205 W. Wacker Drive, Chicago, Ill. • 181 E. Main St., Centerbury, Ohio • 2635 Page Drive, Altadena, California • Grant Bldg., Room 603, Pittsburgh, Pa.

ATTLEBORO, MASSACHUSETTS

What's a pattern maker got to do with **ALUMINUM FORGINGS?**

You've decided on an aluminum forging because of its high strength-weight ratio. But stresses will be complex. You can't be sure of the design until the part is completed, and dies cost a lot of money to make and change. So here's where the multiple interests of Alcoa can serve you:

Patterns are made according to your design. Cast in sand, the piece is then tested in Alcoa's stress analysis laboratory. Patterns are changed to suit, new castings made and tested. Slight changes are made by machining off or welding on metal. When the desired distribution of stresses is obtained, Alcoa's engineers say, "There's your design".

Now we make the forging dies. Because the forging has the same shape and a similar elastic modulus as the casting, stresses will be distributed alike. Alcoa pattern makers and foundrymen, skilled in their arts, have saved you time and money by thus co-operating with Alcoa's forging engineers. ALUMINUM COMPANY OF AMERICA, 2193 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA

ALUMINUM

ALCOA FIRST IN **ALUMINUM**

Why Carpenter Nickel-Iron Alloys Give the Best Answer to the Low Expansion Problem

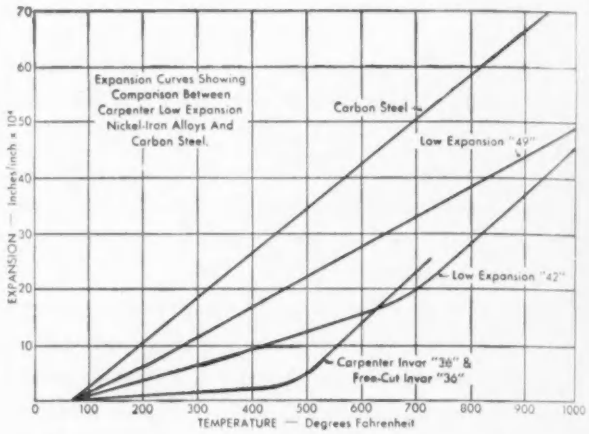
Patented Carpenter Free-Cut Invar "36" Simplifies Machining

For close control or dimensional accuracy of precision parts in devices where a low rate of thermal expansion is a must—Carpenter provides a group of Nickel-Iron alloys to meet this requirement over a wide range of temperatures.

The temperature range in which most applications fall is between room temperature and 400° F. A glance at the chart shows that this range is covered by Carpenter Invar "36". And the fact that this alloy is now also produced in a free-machining grade — Carpenter Free-Cut Invar "36"— greatly broadens its usefulness. For applications requiring a wider range of temperature, Carpenter Low Expansion "42" provides low thermal expansion characteristics up to 700° F. — and Carpenter Low Expansion "49" extends this range up to 1000° F.

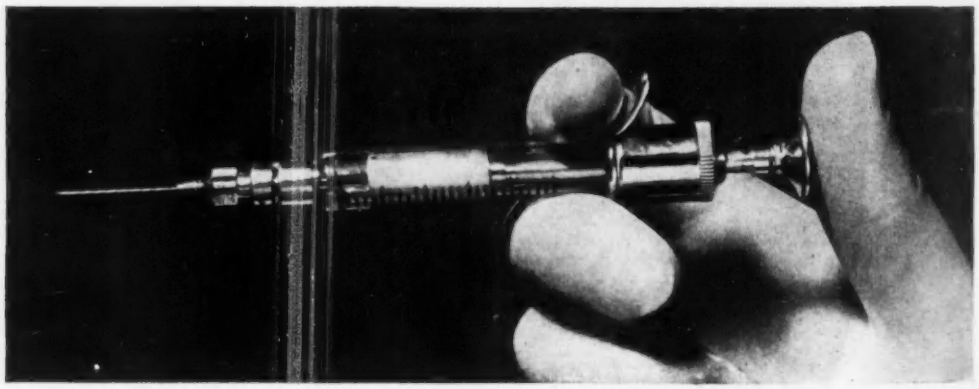
Here, then, are alloys to meet practically any low thermal expansion problem that may come your way. And because of the great care Carpenter takes in making these alloys — melting within a closely controlled analysis range to insure constant uniformity from lot to lot—you can depend on them to give greater accuracy to thermostatic devices, radio equipment, electronic devices, precision scales, etc.

Let us help you apply these alloys to the solution of your design-engineering problems. Get in touch with us today.



Characteristics of Carpenter Low Expansion Alloys.

The plunger in this hypodermic syringe was made from Carpenter Free-Cut Invar "36". The low thermal expansion properties of this alloy keep the plunger dimensions constant, even during sterilization in boiling water. And the alloy's free-machining qualities made it possible to produce the plunger to the necessary close tolerances for a flush fit in the glass cylinder, so essential in the operation of this instrument.

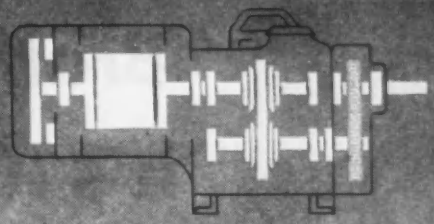


ASK FOR A COPY of our latest engineering bulletin on Carpenter Invar "36" and Free-Cut Invar "36". Our Metallurgical Department will be glad to supply information on the other alloys.

The Carpenter Steel Company, 117 W. Bern Street, Reading, Pa.

Carpenter High Nickel Alloys

- Temperature Compensator "30"
- Carpenter Invar "36"
- Carpenter Free-Cut Invar "36"
- Glass Sealing "42"
- High Permeability "49"



Stepless VARIABLE SPEED operation

offers tremendous advantages on many applications. A superior quality product and increased production will result in nearly every case.

Thousands of alert engineers, like you, have found that the best way to secure these advantages is with Master Speedrangers . . . the compact, all metal units of proven reliability.

For example, look at the ring grinders shown below. The Speedranger, on the drive unit, by incorporating also a gear reduction on one end and an electric brake on the other end . . . all designed and built into one compact integral power drive . . . provides variable speed, at exactly the right range. In addition, the machine can be quickly stopped and started again for increased production.

The other Speedranger provides smooth, stepless, variable speeds from 600 to 5000 RPM for the grinding wheel.

Each Speedranger mounts neatly on the machine, saves space, saves money, and greatly improves the output, appearance, and convenience of the equipment.

Probably you will not need this same combination of features. However, the next time you need a drive for material processing, handling, and conveying equipment; mixers and agitators; weld-positions; machine tool drives; testing and calibrating equipment . . . to name only a few . . . see what a really remarkable job Master Speedrangers can do for you.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

"Brother, take it from me... it's 100% Easier to Drive 50% More Screws in a Day!"

...that's what users of AMERICAN PHILLIPS SCREWS tell users of Slotted Screws

Workers on screw assemblies feel as though they had been freed from a chain gang, when their production chiefs liberate them from slow, exhausting, *high-cost* slotted screw driving . . . up to speedy, easy, *low-cost* American Phillips Screws and 4-winged Phillips power drivers.

For then they find that they can make their jobs amount to something . . . that it's actually far easier to do better work and more of it . . . yet still end their shifts without undue fatigue. Simply because American Phillips Screws drive automatically straight—and because the 4-winged driver can't jump out of the recess.

So management finds that . . . by increasing workers' safety, earning power, and morale . . . there's a fairer return on fixed overhead charges. And *you* will find, when you change to American Phillips Screws, that you get *extra* returns from American's quality-control and American's three-point inspection of head, thread, and point that assures full usable value in every shipment. Whether you use standard or special screws, you'll save 50% over slotted, by changing to American Phillips Screws. Write.

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

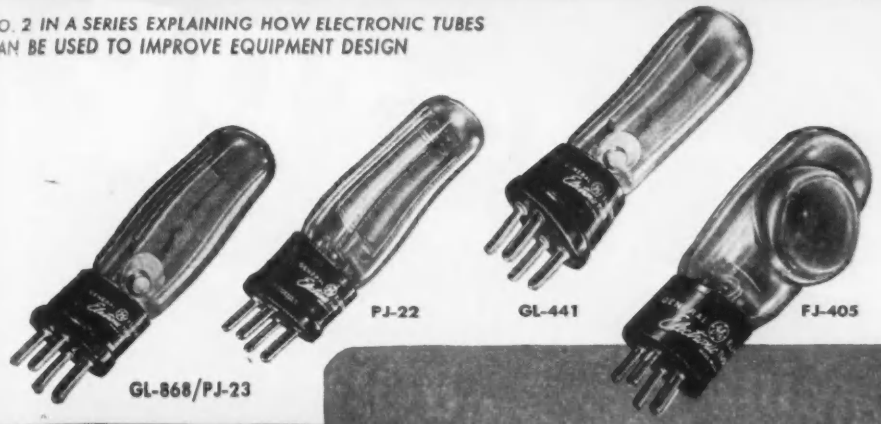
Chicago 11: 589 E. Illinois Street — *Detroit 2:* 502 Stephenson Building

Take a Recess from Slotted-Screw Costs and Troubles ...the Tapered, Engineered Recess of:

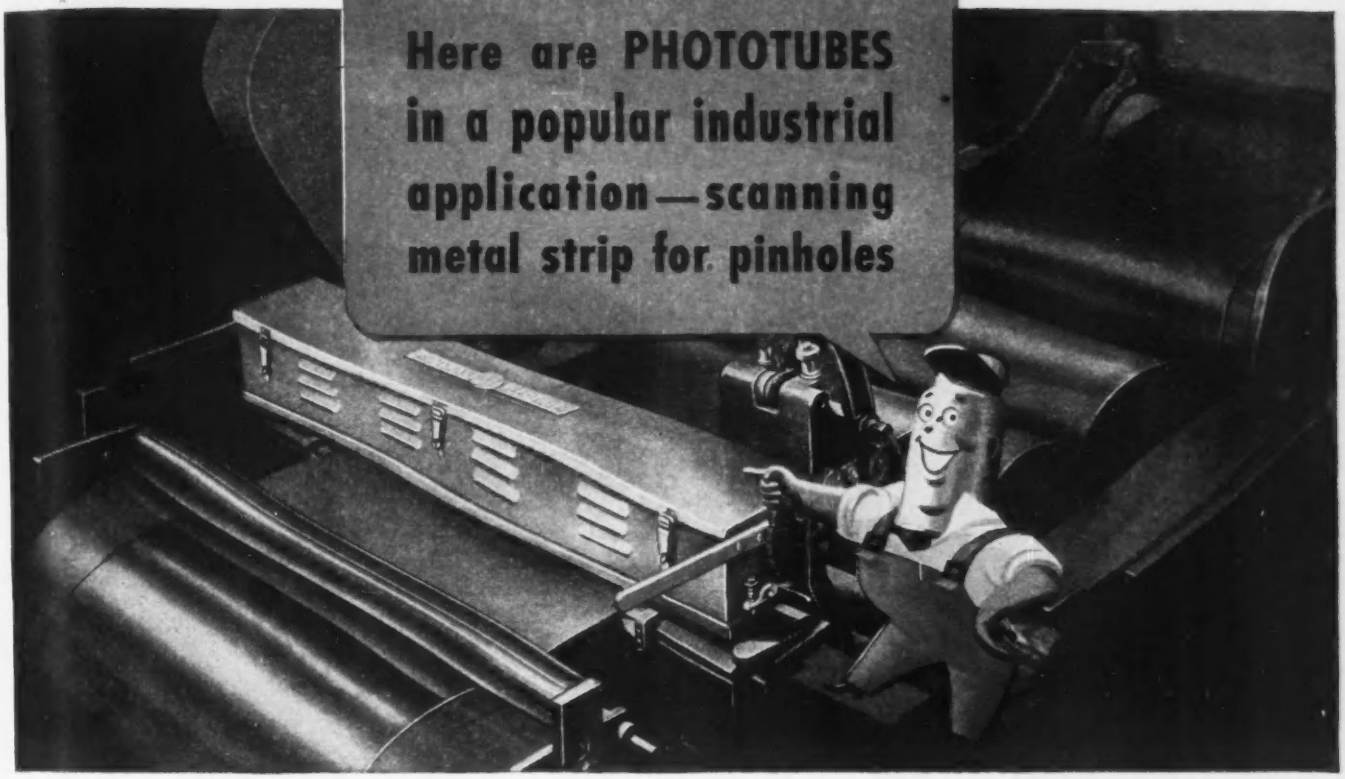
AMERICAN PHILLIPS *Screws*

Put the Screws on the Japs . . . BUY BONDS!

NO. 2 IN A SERIES EXPLAINING HOW ELECTRONIC TUBES CAN BE USED TO IMPROVE EQUIPMENT DESIGN



GL-868/PJ-23 is gas-filled and the others vacuum types. Spectral response of GL-868/PJ-23 (R. M. A. standard) is S1, sensitivity to light 90 microamperes per lumen, anode voltage 100—price $2.60. For PJ-22 the same ratings in order are S1, 20 mu a, 500 v—price $2.60. For GL-441 ratings are S4, 45 mu a, 250 v—price $4.50. For FJ-405 (a special ultra-violet-responsive tube) ratings are S6, 12 mu a, 200 v—price $42.



These G-E tubes that "see" will do scores of automatic jobs faster—more accurately—more reliably—at lower cost

When your designing staff is faced with a problem that involves grading product for size, counting or sorting manufactured articles coming off the line, positioning material being fed into machines, or doing rapidly and infallibly other work which calls for properties of visual selection, then it is time to check into phototubes as the best and most practical method of handling the job.

Wherever the interruption of a beam of visible or invisible light can be made to have functional meaning, phototubes may be used to initiate the operation of control apparatus. Jobs such as aligning paper on presses for accurate register, signaling content-levels in bins or tanks, sounding alarms when moving equipment exceeds safe limits of travel—these call for phototubes as the fastest-operating, most practical and reliable method of doing the work.

Consult General Electric on phototube applications and circuits for greater efficiency and economy in the operation of your equipment. Your nearest G-E office or distributor will supply information on phototubes or other industrial electronic tubes. Also ask for "How Electronic Tubes Work," a non-technical booklet on industrial tubes and their applications. *Electronics Department, General Electric, Schenectady 5, N. Y.*

Hear the G-E radio programs: *"The World Today" news, Monday through Friday, 6:45 p. m., EWT, CBS. "The G-E All-Girl Orchestra," Sunday 10 p. m., EWT, NBC. "The G-E House Party," Monday through Friday, 4 p. m., EWT, CBS.*

G-E HAS MADE MORE BASIC ELECTRONIC-TUBE DEVELOPMENTS THAN ANY OTHER MANUFACTURER

GENERAL ELECTRIC

162-04-8850

METALUSTRE

the gleaming metallic enamel of a thousand uses . . .

for PRESENT or Post-War PRODUCTS

THESE lacquer and synthetic enamels contain bronze powder and dry with a lustrous metallic effect. They are supplied in twenty-eight standard colors. Metalustre enamels are tough, durable, and perspiration-resistant. They have good adhesion and cover well in one spray coat. They may be used as one coat finishes on metal or over lacquer or synthetic undercoats as well as wrinkle enamels. Write for full information and also ask for our booklet, "Information on U. S. Government Finishes," containing up-to-the-minute lists of specifications and the M & W finishes which meet them.

for a quick "Finish"
Buy More War Bonds

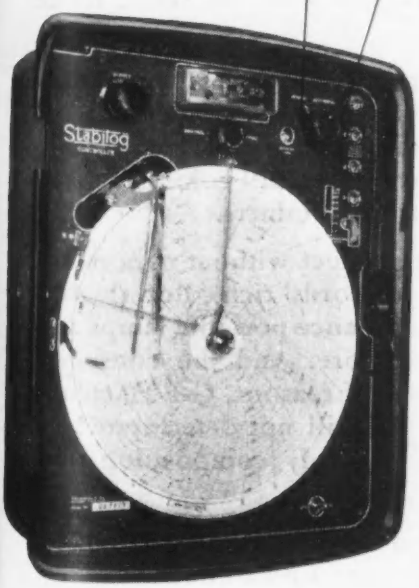
M & W

MAAS & WALDSTEIN COMPANY, NEWARK, N. J.

PRODUCERS OF LACQUERS, ENAMELS, SYNTHETICS AND SPECIALTY FINISHES FOR ALL PURPOSES

BRANCH OFFICES & WAREHOUSES: 1658 CARROLL AVE., CHICAGO, ILL. • 1228 W. PICO BLVD., LOS ANGELES, CALIF.

This gasket prevented leakage in this pneumatic transfer switch



Here is a story that may help you solve a sealing problem: The design of the rotary transfer switch in the Foxboro Stabilog Controller, used in critical processes involving temperature, pressure, and flow, required the use of a small gasket with an unusual combination of characteristics.

The problem was a difficult one because the part had to serve the dual purpose of gasket and valve. The seal had to be positive yet the switch had to turn easily on the face of the gasket—the material had to be abrasion-resistant and non-extruding. The Foxboro Company turned to Armstrong's engineers for help in solving their problem.

Specifications were met exactly by one of Armstrong's Cork-and-Synthetic-Rubber Compositions. Self-lubricating, relatively incompressible, and having little flow, it prevented leakage. Gaskets made from this Armstrong's Cork-and-Synthetic-Rubber Composition are now giving perfect performance in hundreds of Foxboro Stabilog Controllers.

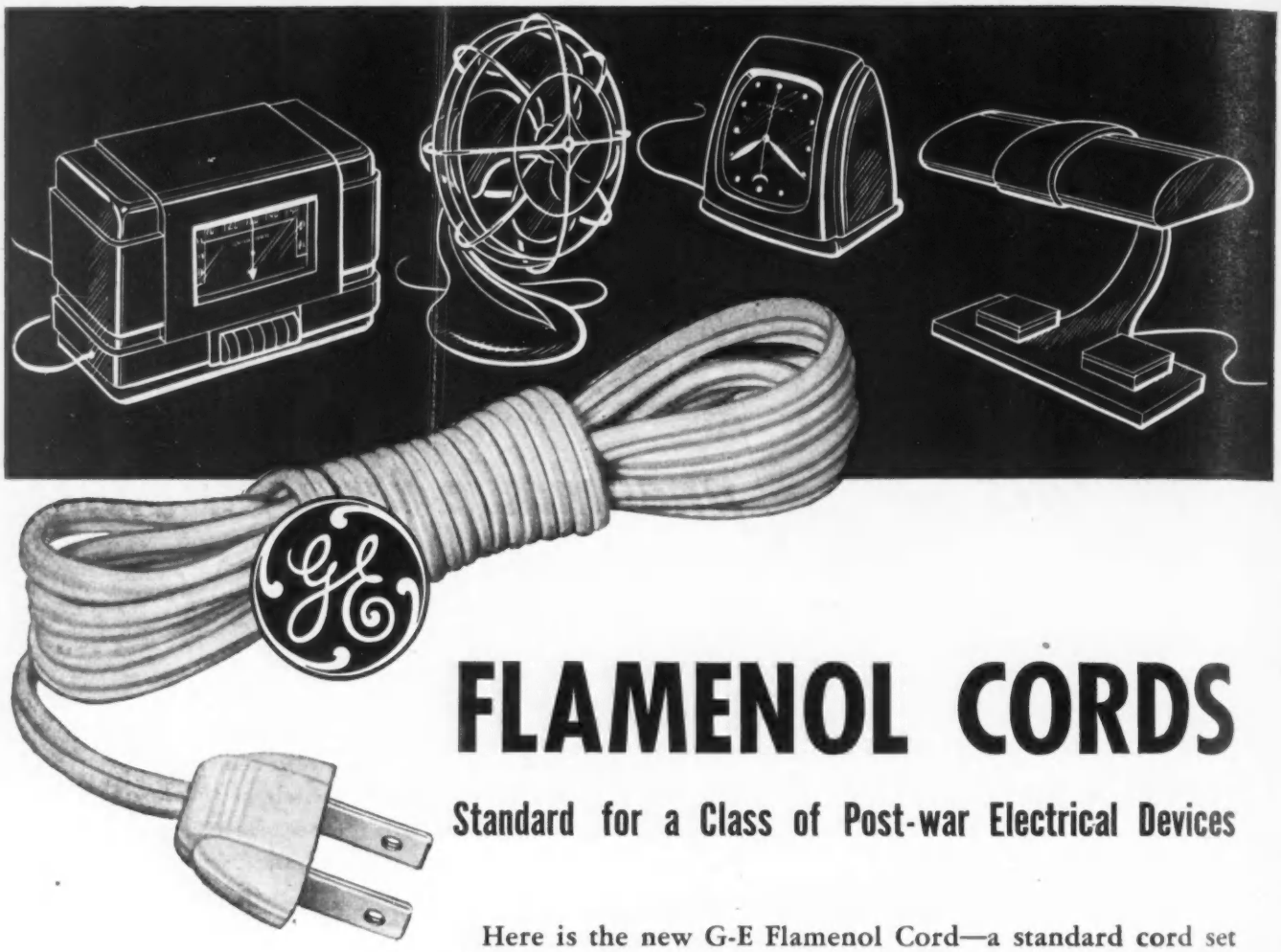
The long experience and wide selection of materials that enabled Armstrong's engineers to solve this problem may help solve yours, too. Send complete information about your application to Armstrong.

SEND FOR FREE BOOKLET

For descriptions of Armstrong's Sealing Materials, see Sweet's File for Product Designers. Or write us for your copy of the free booklet, "Gaskets, Packings, and Seals." Address Armstrong Cork Company, Gaskets and Packings Department, 7102 Arch Street, Lancaster, Penna.

ARMSTRONG'S
GASKETS · SEALS · PACKINGS

Cork Compositions • Cork-and-Synthetic Rubber Compositions
Synthetic Rubber Compounds • Cork-and-Rubber Compositions
Fiber Sheet Packings • Rag Felt Papers • Natural Cork



FLAMENOL CORDS

Standard for a Class of Post-war Electrical Devices

Here is the new G-E Flamenol Cord—a standard cord set that will add to the appearance and value of small traffic appliances and portable lamps.

In the past, it was customary to display electrical appliances and lamps with the cord sets shown as inconspicuously as possible. Even when rubber cords were of the best quality and neatly coiled, their coarse texture and dull color detracted from the appearance of fine electrical products.

Post-war you can display your product without concealing these G-E Flamenol Cords. Flamenol Cords' rich color, smooth texture and beautiful finishes will enhance portable lamps and other small appliances as never before. And the consumer will be more satisfied for a number of reasons. G-E Flamenol Cords have unusually long life. Oil will not deteriorate nor will sunlight adversely affect the sturdy composition and fine finishes of these cords.

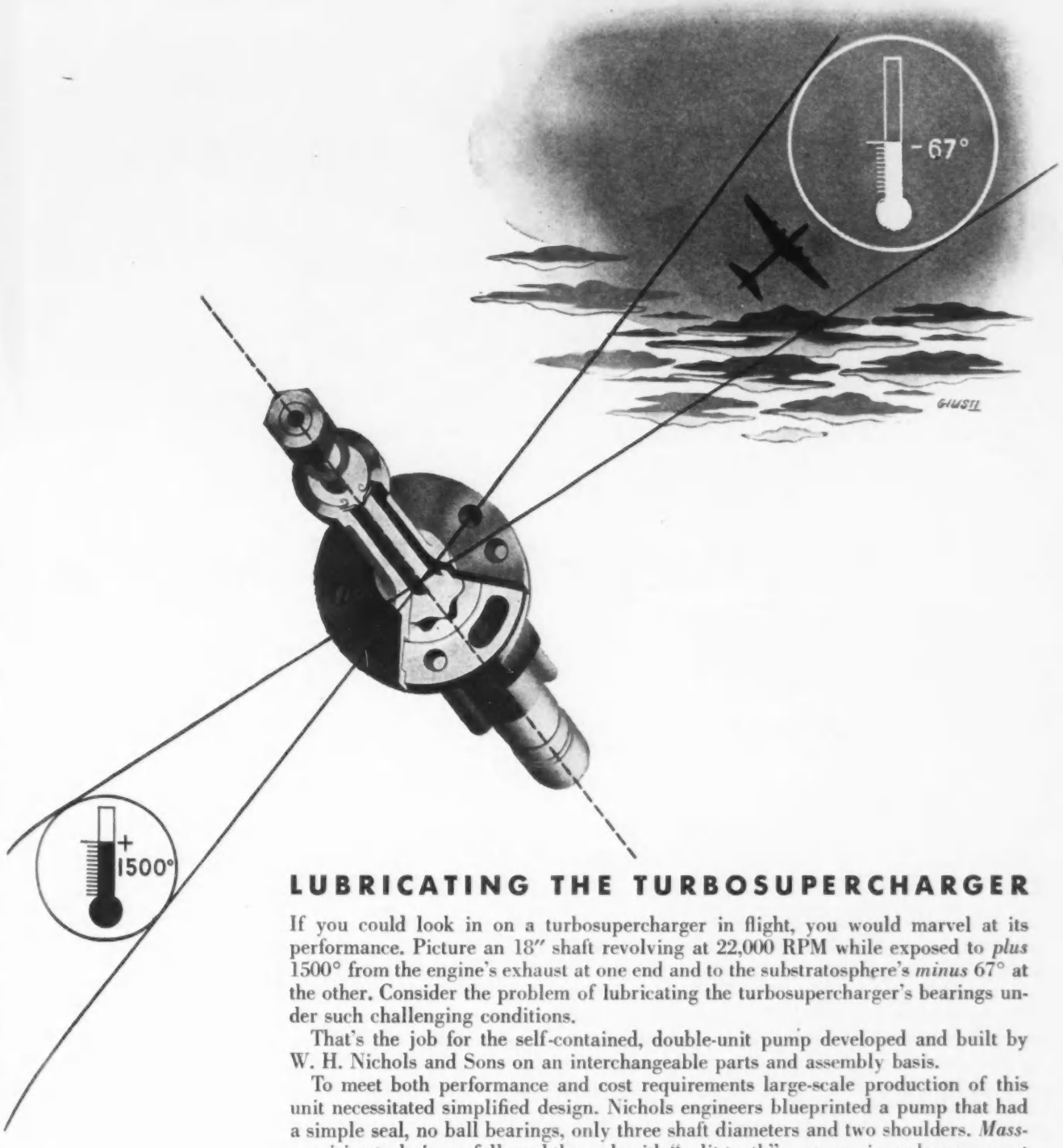
Section Q253-42, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

BUY WAR BONDS AND KEEP THEM

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The G-E House Party" Monday through Friday 4:00 P.M. CBS.

GENERAL ELECTRIC

ANOTHER MASS-PRECISION ASSEMBLY BUILT BY NICHOLS



LUBRICATING THE TURBOSUPERCHARGER

If you could look in on a turbosupercharger in flight, you would marvel at its performance. Picture an 18″ shaft revolving at 22,000 RPM while exposed to *plus* 1500° from the engine's exhaust at one end and to the substratosphere's *minus* 67° at the other. Consider the problem of lubricating the turbosupercharger's bearings under such challenging conditions.

That's the job for the self-contained, double-unit pump developed and built by W. H. Nichols and Sons on an interchangeable parts and assembly basis.

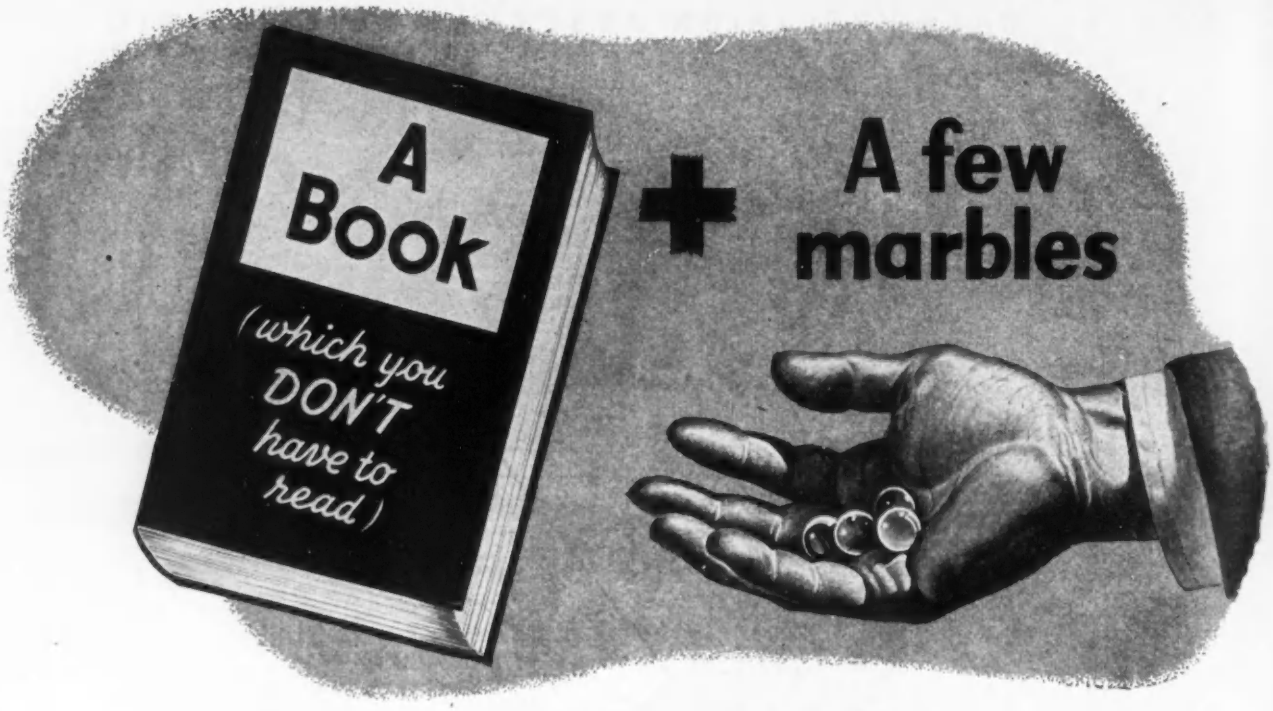
To meet both performance and cost requirements large-scale production of this unit necessitated simplified design. Nichols engineers blueprinted a pump that had a simple seal, no ball bearings, only three shaft diameters and two shoulders. *Mass-precision* techniques followed through with "split-tenth" accuracy in each component part and avoided costly, step-by-step inspection. Despite the close fits, *all parts are assembled without pre-selection.*

The same ingenuity for precision manufacture on a mass-production basis has solved other equally difficult problems for over forty years. Here unique facilities have been developed for producing the "hard" parts. They may be your answer for working out that post-war product. Let "Accurate" Nichols help you see it through.

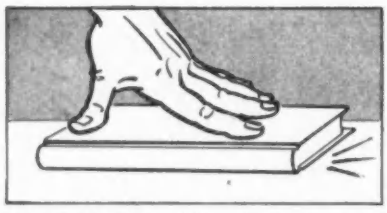
W. H. NICHOLS & SONS, 48 WOERD AVENUE, WALTHAM 54, MASS.

"Accurate" *Nichols*

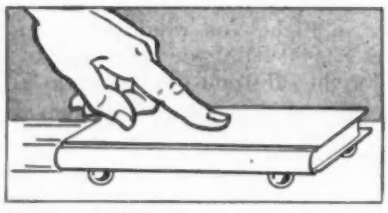
PRECISION ENGINEERING AND MANUFACTURING FACILITIES FOR MASS PRODUCTION



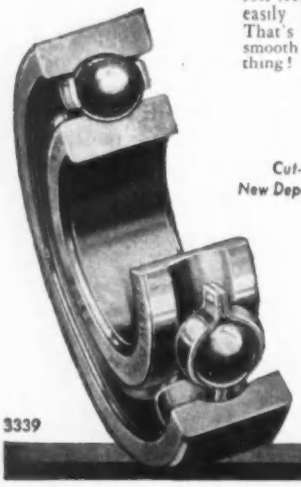
tells the WHY of Ball Bearings



TRY THIS: Place a book on your desk and your hand firmly on it. Then try to push the book across the desk. That's the principle of *sliding motion*—hard on book, desk and energy.



THEN THIS: Place 4 marbles under the book, your hand on top—and push. The marbles roll freely, the book moves easily in any direction. That's *rolling motion*—smooth and easy on everything!



Cut-away view of New Departure Ball Bearing

There is a simple, fundamental truth in the principle of the ball bearing: "Nothing Rolls Like a Ball!"

The ball possesses inherent advantages unequalled by any other rolling body. There are no *ends* to a ball—so its axis of rotation need never be artificially fixed.

Thus, a *Ball* bearing bears the loads on a circle of *free rolling* steel balls, reducing friction and wear, maintaining precise location of parts and cutting maintenance time—as does no other type bearing.

That is why over 300 million New Departure Ball Bearings are at work in this war. *That* is why designers of peace-time machinery are designing more ball bearings into their machinery than ever before.

There is really no substitute for the ball bearing—nor any substitute for the technical experience and creative engineering that go into New Departure Ball Bearings.

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Of course, this isn't an argument in favor of the all-plastics home or postwar automobile . . . far from it. It is merely a reminder of the touch comfort to be had from Lumarith, and a reference to the many places where these Celanese* Plastics make the things we touch "feel better".

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The automobile steering wheel and controls—even our clothes buttons, eyeglass frames, compacts, cigarette cases and pocketbook clasps are smooth and pleasant to touch when they are made of Lumarith. Yes, from cellar to attic, at the office or in the driver's seat, the things we touch should bring us comfort. That is what Lumarith plastics are designed to do. Celanese Plastics Corporation, a division of Celanese Corporation of America, 180 Madison Avenue, New York 16, New York.

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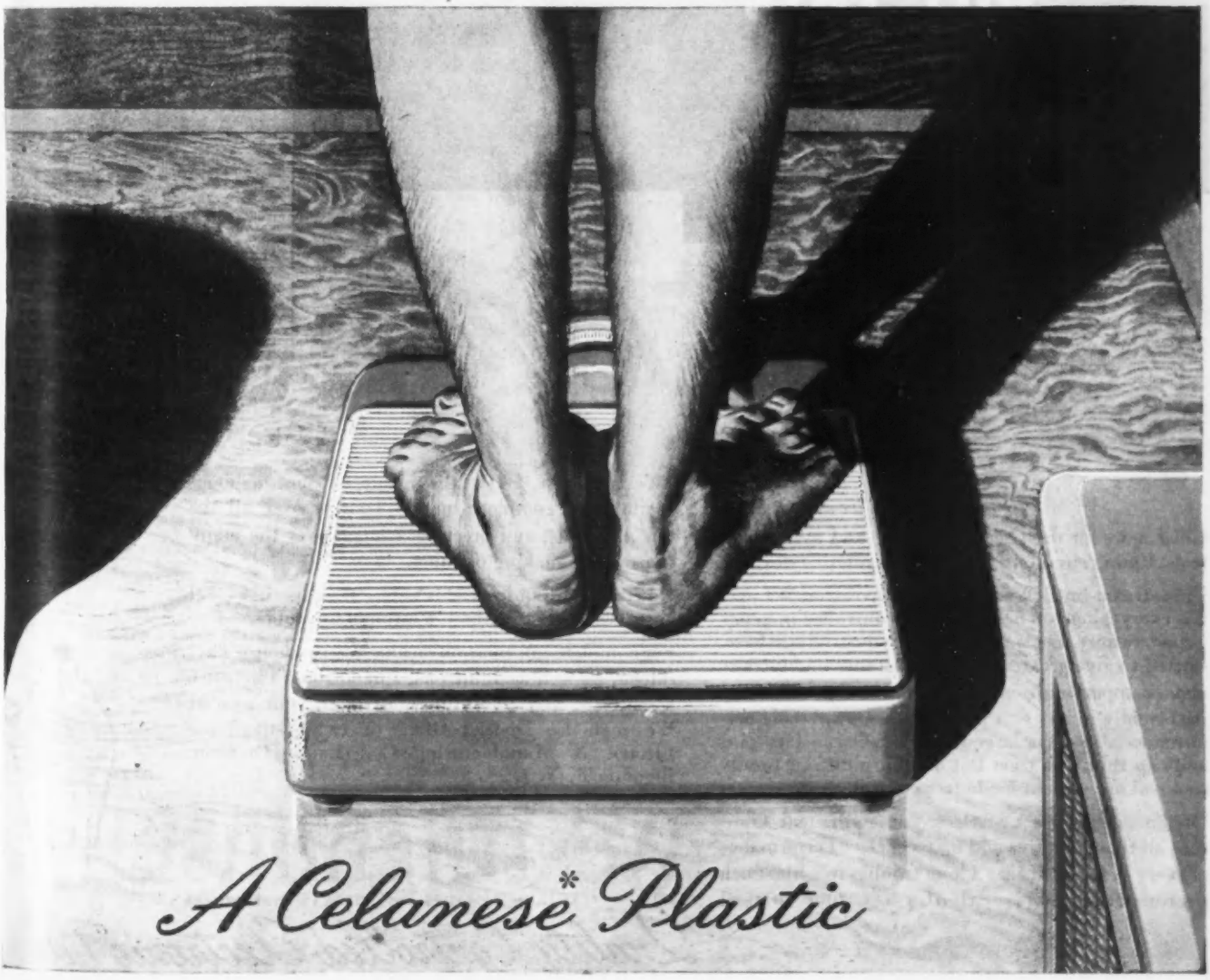

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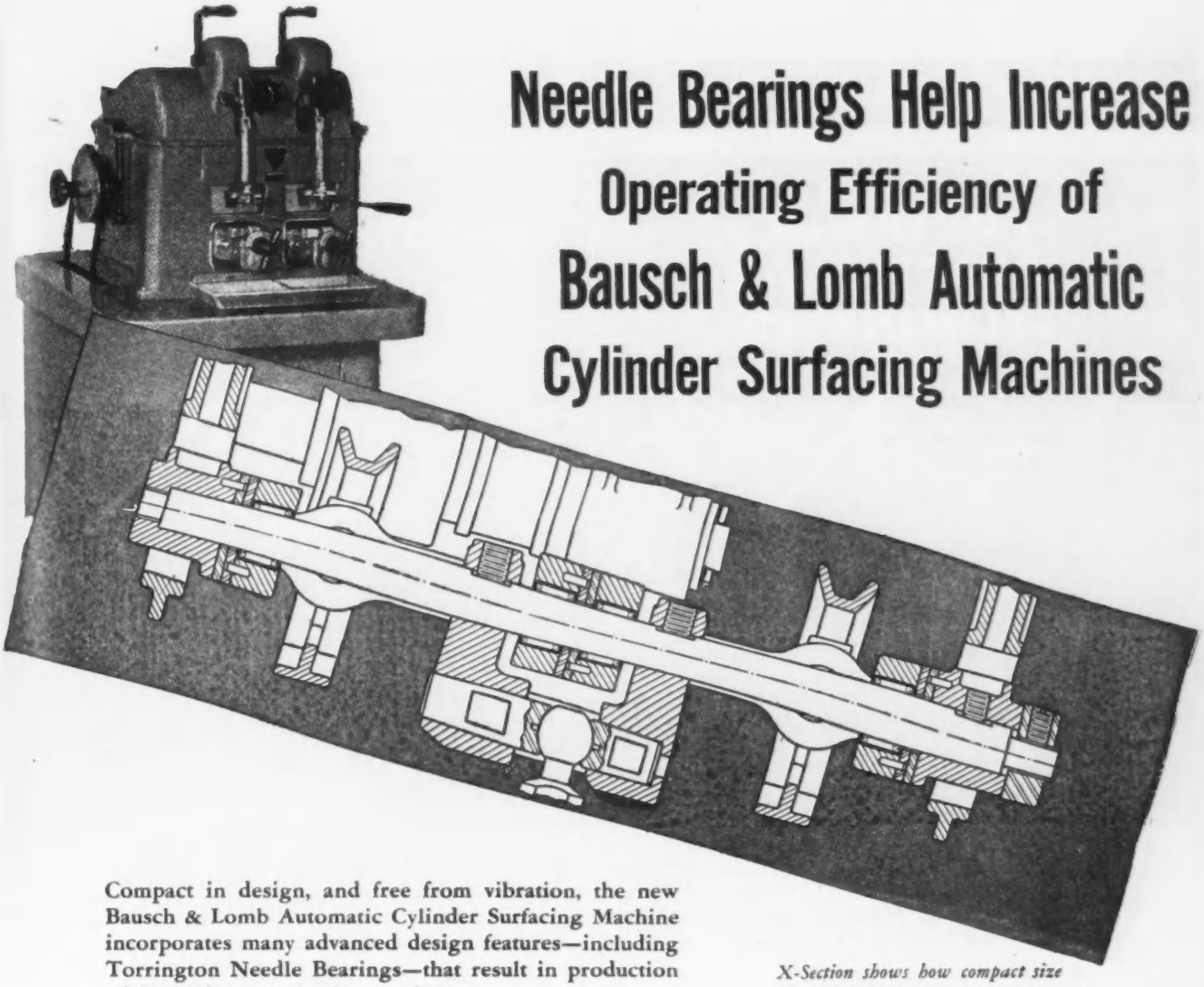

Needle Bearings Help Increase Operating Efficiency of Bausch & Lomb Automatic Cylinder Surfacing Machines

Compact in design, and free from vibration, the new Bausch & Lomb Automatic Cylinder Surfacing Machine incorporates many advanced design features—including Torrington Needle Bearings—that result in production of the highest quality lens surfaces.

Many manufacturers planning new products can take a tip from this machine. For it clearly illustrates how Torrington Needle Bearings with their unique advantages of compact design, high load capacity, light weight, and efficient lubrication help increase operating efficiency and lower costs.

Consider also the production and sales advantages that stem from the use of Torrington Needle Bearings in your own plans. Complete information on types, sizes, and ratings, along with a list of typical Needle Bearing applications will be found in Catalog No. 30-A. Send for your copy today.

X-Section shows how compact size Needle Bearings aid in design of operating mechanism on B & L Surfacer.

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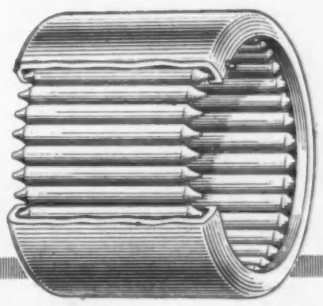

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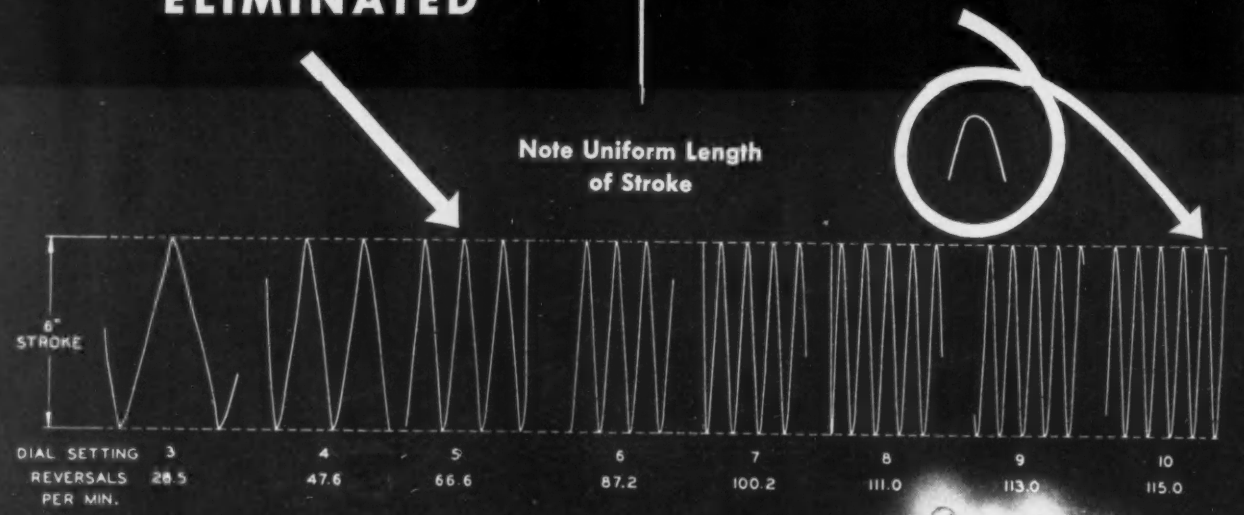
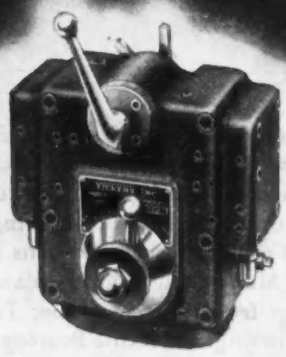
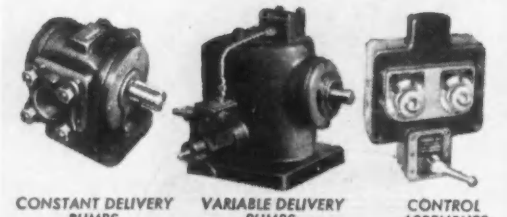
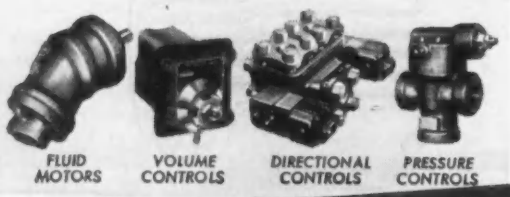


VICKERS "RECIPROCATING CYCLE" CONTROL PANELS







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PRODUCT ENGINEERING

FEBRUARY, 1945

Organizing Knowledge of Materials

B. C. BOULTON
Engineering Divisional Staff, Douglas Aircraft Corporation

Presenting a method of organizing industry's information on old and new materials into factual data to meet engineering demands based on progress. Concrete suggestions are cited in an effort to crystallize thinking on the subject and to curtail the duplication of effort in various laboratories.

THE insistent demands of design engineers for more efficient materials for both old and new uses result in the introduction of so many new materials that we find difficult the task of determining their characteristics, as well as systematizing for use the accumulated knowledge of older materials. To add to the problem, many of the criteria or yardsticks that have so honorably served other engineers for decades are no longer adequate. For instance, elongation in 2 inches is a term almost hallowed by usage and regarded as a basic characteristic of a material, yet aircraft engineers have the temerity not only to question, but to state that it has no fundamental meaning. Instead, there is talk of an unfamiliar, zero gage length elongation, and an elongation in 100 in. They also insist on knowing the strength of a material at 300 deg. F., or what strength it has after being subjected to that or to other temperatures for a thousand hours.

New Material Data

What is the situation at the time that the sales engineers of a vendor first tell of a new material? It is seldom that the producer can supply more than meager information as to the principal and readily determined mechanical and physical properties. If the material is a structural type with a potentially broad use, these values serve only to stimulate interest and may make the advantages appear sufficiently outstanding to initiate testing and research programs in a score or more of laboratories to secure additional data. Hard experience has amply demonstrated the danger of introducing an unknown material, even for experimental construction, without exploring the many pitfalls in both design and fabrication.

The nature and potential uses for a material determine the amount of information needed. In the case of a special purpose material the required data may be limited, but on the other hand with a widely used structural material, such as a new aluminum alloy, a vast amount of information is essential before it can be put to intelligent, safe, and economic use. Its many strength properties and the expected variation in their values must be known. Data must be obtained as to general physical properties and an extensive knowledge must be acquired with regard to the numerous fabricating characteristics and methods of processing. In addition to these physical data, it is essential that there be dependable information on the availability of the material as to time, sources, volume, forms and sizes. For the postwar period, costs of a new material may be a governing factor in its use.

Cooperative Efforts

Prior to the present war there was little organized effort to obtain this almost bewildering mass of information, and generally several years were required to secure even a reasonable working knowledge of an important new material. During the war the necessities of advanced design, or material shortages requiring substitutions, forced a good deal of valuable cooperative effort. One important program was in connection with the introduction of the National Emergency or triple alloy steels in place of the widely used SAE steels. In this case different companies and organizations were allocated the task of determining the comparative characteristics of these two classes of materials. This allocation of responsibility and the wide exchange of information considerably accelerated the use of the new steels.

The latest government venture in cooperation in the material field is the newly organized NACA Committee on Materials Research Coordination. The departure from previous NACA policy, namely active participation of industry on this committee augurs well

Table I—Check List for Characteristics of a Metal

Purpose of this list is to present reasonably complete listing of all properties of a metal so that when a specific metal is under consideration, those desired properties pertaining to it may be readily selected and their priority determined. The list is of assistance in assuring that no properties are overlooked.

Physical Characteristics

General

- Density
- Thermal coefficient of expansion
- Electrical conductivity
- Thermal conductivity
- Position in electromotive series (Solution potential)
- Corrosion characteristics in: (A.S.T.M. Committee B-3)
  - Atmosphere
  - Salt water
  - Acids
  - Hot gases
  - Rapidity of corrosion
  - Susceptibility to stress corrosion
  - Effect of high temperatures on corrosion resistance
- Maximum temperature not affecting strength characteristics
- Effect on strength after exposure to higher temperatures
- Fire resistance
- Hydraulic permeability in different forms
- Creep characteristics vs. temperature
- Melting point
- Hardenability
- Effect of cold-working
- Wearing qualities:
  - Inherent
  - Given by heat-treatment
  - By plating
- Ballistic properties
- Damping coefficient
- Crystal structure type
- Magnetic properties (Curie Point)
- Chemical composition

Strength or Mechanical Properties

- Tension modulus of elasticity
- Compression modulus of elasticity
- Complete stress-strain curve for both tension and compression
- Shear modulus of elasticity
- Poisson's ratio

Compression yield	Typical values. Variability. Design values with and across grain.
Tension yield	
Tension ultimate	
Shear ultimate	
Bearing ultimate	

- Tangent modulus curves in compression—with and across the grain.
- Fatigue properties:
  - S-N curve
  - Endurance limit
  - Notch sensitivity
- Impact Properties:
  - Notch sensitivity
  - Effect of low temperature
- Above strength properties:
  - (a) At elevated temperatures and for long holding times at temperature
  - (b) At room temperature after exposure to elevated temperatures
- Hardness

Fabricating Characteristics

I. Machinability:
- Best cutting speed
- Material and shape of cutting tool
- Lubricant or coolant
- Fire hazard

Qualitative suitability for:
- Routing
- Sawing
- Shearing
- Drilling
- Turning
- Milling

II. Formability in:
- Annealed, W, and tempered states
- True stress-strain curve
- Apparent stress vs. local strain curve
- Elongation vs. gage length from zero to 100 in. gage length
- Standard hydropress specimen test

Characteristics in:
- Shrinking
- Drawing
- Stretching
- Dimpling
- Joggling
- Bending

Uniformity of characteristics

III. Formability at elevated and room temperature:
- Heat-treating characteristics
- Annealing procedure
- Tempering procedure
- Quenching procedure
- Sensitivity to variation
- Aging characteristics

IV. Weldability:
- Arc welding
- Torch welding:
  - Type of welding rod
  - Cracking tendency
- Heliarc welding
- Atomic hydrogen welding
- Spot welding
- Electric flash welding
- Pressure welding

V. Brazing and soldering:
- Flux and rod

VI. Torch cutting

VII. Quality of finish: (smoothness) possible

VIII. Protective coating necessary for:
- Storage
- Processing
- Service
- Plating
- Anodizing
- Paint adhesion
- Sensitivity to contamination

Economic Factors

I. Cost in different forms

II. Availability:
- Single or multiple source

III. Availability in different forms:
- Sheet
  - Bare or Clad
- Bar
- Wire
- Tubing
- Extrusion
- Impact extrusion
- Pressing
- Forging
- Casting:
  - Sand
  - Centrifugal
  - Permanent mold
  - Die casting
- Powder
- Sintered powder pressing
- Uniformity of material and relative freedom from defects

IV. Size limitations in different forms:
- Weight
- Gage
- Length
- Width

V. Availability as to time:
- Present
- Future

VI. Availability as to quantity:
- Limited
- Unlimited

VII. Size tolerances for all forms

for its usefulness. Another notable example of effective cooperative effort in this direction has been the valuable work of the National Defense Research Council through the War Metallurgy Committee. This organization has utilized the resources of many great industrial and university research laboratories with their staffs of able technical men to secure knowledge of materials both old and new, particularly with regard to characteristics hitherto unexplored but vital to war production.

One of the most hopeful developments of the war has been the exchange of information between aircraft companies through the activities of the several Aircraft War Production Councils. Even with all these efforts, each major aircraft company set to work gathering the necessary data in their own laboratories. This obviously involves an immense duplication of effort and frequently information on some important property or characteristic is not obtained.

Check List of Properties

To get a complete picture at the beginning of a testing program, to facilitate organization of the work and insure that no essential item will be overlooked, the Douglas Company prepared a check list of the properties of a metal. This list is shown in Table I. Similar check lists with appropriate properties could of course be prepared for plastics or rubber or any non-metallic material. The first impression one is apt to receive on study of this list is its extensiveness and the tremendous amount of information required. This may cause some discouragement, and perhaps a feeling that some of the items are rather far removed from practical needs. These impressions are partly due to the fact that the table is intended to cover all general classes of metals and it is to be emphasized that numerous items, while needed in one case, are not applicable in another. The problems are somewhat further simplified by the fact that many of the characteristics are not essential for initial design or fabrication work. Hence, in using the list for a specific material it is first necessary to decide what items are inapplicable and then to arrange the remainder in the order of priority.

In the past, design and production work has frequently proceeded without adequate knowledge of the characteristics of a material, with the result that often the missing information had to be acquired by costly trial and error. Because of the impracticability of determining the many fabricating characteristics of a material on actual parts, a great deal of thought has been given in the last few years to the development or specific criteria for standard simple tests which will give either quantitative or qualitative information. Frequently these are of most value when comparative, so that a given characteristic of a new material may be compared with that of a familiar material whose fabricating limitations are well known. It is believed that the development and general acceptance of reliable tests and criteria, particularly with regard to the different types of formability, is of much importance. Such criteria would greatly simplify and facilitate the work of determining the fabricating limitations of a material, the type of tooling required, and the precautions that must be taken. They would enable design and tooling to proceed with a reasonable degree of confidence even though a specific operation may never have been performed on the new material.

Material Characteristics

Some review of a few of the more unusual items contained in the check list may be of interest in showing the practical reasons for their inclusion. Why should there be interest in such general properties as the ballistic properties of a structural material? In early efforts to provide limited protection against gunfire for the crew, fuel tanks and vital parts of an airplane, steel armor plate was used almost exclusively. It was then found that certain aluminum alloys in heavy gage sheet or plate were effective in deflecting bullets and could also serve as an integral part of the structure, with a resulting simplification of design and a weight saving. But all of the structural aluminum alloys were not alike in ballistic properties and tests were necessary to determine which would shatter and which would provide the greatest resistance to gunfire.

Sometimes specific data are necessary in distinction to general information. A case in point is the relative hardenability of 4140 and NE8740 steels, especially in heavy sections. The great pressure brought by the War Production Board for this substitution caused many long continued arguments as to the safety of the substitution in certain cases. Only recently have definite comparative data been available which prove without question the considerable inferiority of NE8740 with high heat-treatments and heavy sections. Another example is hydraulic permeability which must be checked if a material is to be used for parts subjected to high hydraulic pressures which may run up to 3,000 lb. per sq. in. Most aluminum alloy castings are unsatisfactory for such use.

Mechanical Properties

The refinements of modern structures now require much more extensive knowledge of the strength properties of materials. An interesting example is the use of the tangent modulus curve shown in Fig. 1. Normally, the modulus of elasticity within the elastic range only was used or even recognized. The design of columns which, in the short column range, may be loaded well beyond the yield point was determined by empirical formulas based on test data. Use of the tangent modulus per-

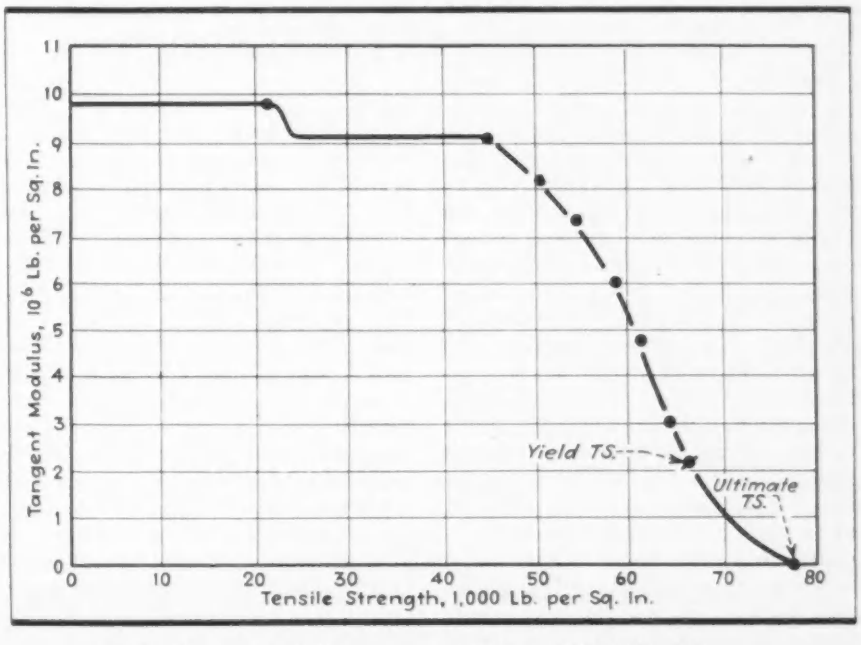


Fig. 1—Variation of the tangent modulus of 75STAL with stress.

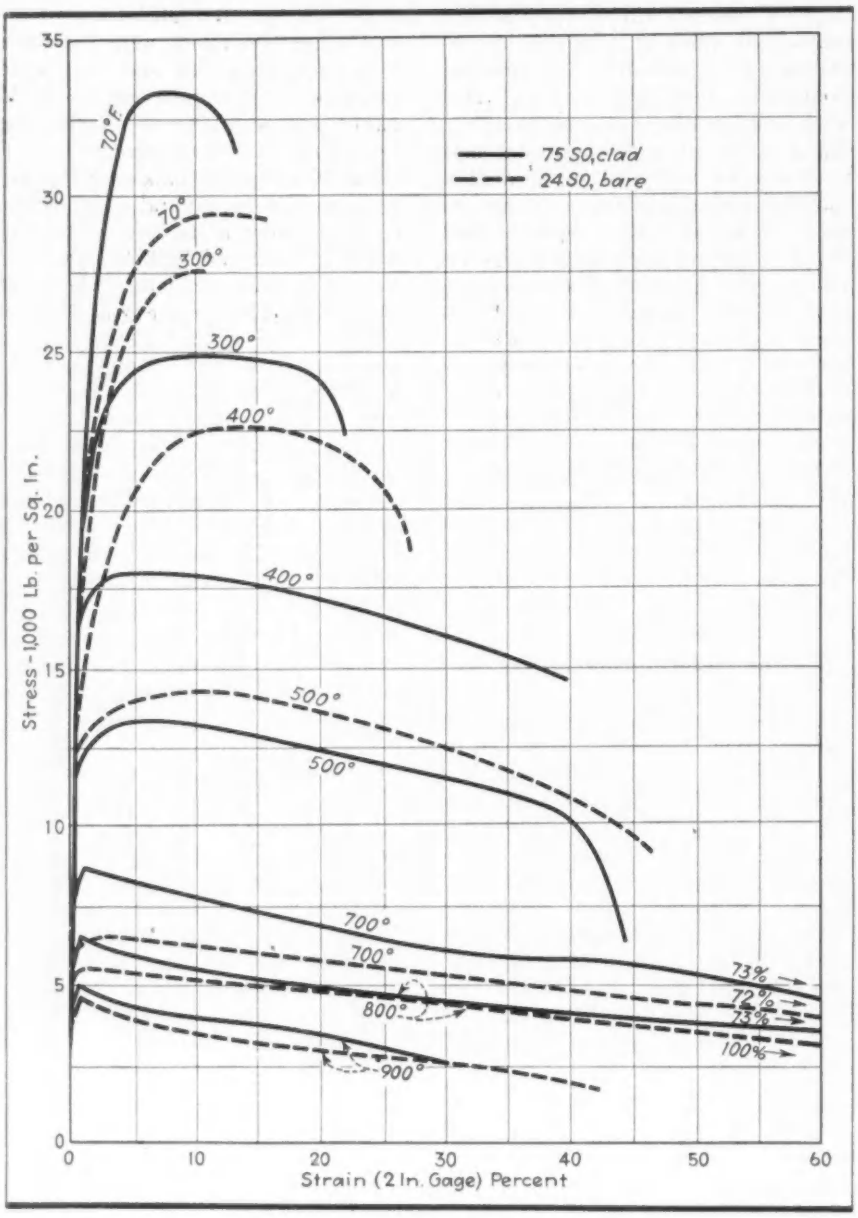


Fig. 2—Comparison of tensile stress-strain curves, at various elevated temperatures, for 75SO clad and 24SO bare.

mits a more reasonable approach to the design of short columns and a prediction of their strength without column tests. In modern design practice one of the most useful of tools is an accurate and complete stress-strain curve. Previously in the design of beams or parts involving bending, formulas based on Hooke's law were employed, even though it was well known that long before failure this law ceased to apply. When a metal was stressed in the plastic range, arbitrary form factors were often used to account for the disparity between calculation and tests. Now, by utilization of information given by the stress-strain curve in the plastic range, engineers can design with confidence and without having to incorporate factors of ignorance.

What happens to the strength properties of a material when it is either occasionally, or continuously for long periods, subjected to elevated temperatures? This problem on which, except in the case of steels, practically no information existed until recently, has caused a lot of worry to many designers. They have had to deal with aluminum alloy structures such as are involved in a heated leading edge deicer or in an aircraft engine compartment. Only recently has the excellent research work of Professor Dorn, and others under the War Metallurgy Committee given quantitative data to the designer. The general effect of heat on aluminum alloy materials is shown by Fig. 2 which clearly brings out the typical large decrease in tensile, yield and ultimate strength, and the fact that although the total strain is increased this is entirely in local elongation at the expense of uniform elongation. Interestingly enough this has shown that some of the new high-strength aluminum alloys are much more adversely affected by high temperature conditions than 24ST. To structural engineers, the advent of these high-strength aluminum alloys with their relatively low elongations has brought another headache. What is the relative notch sensitivity of such alloys under impact, fatigue, or even simple tension, compared with 24ST? Some recent and extremely interesting work has indicated the possibility of establishing actual index numbers which will define quantitatively the notch sensitivity of different materials and also of different types of notches.

Fabricating Characteristics

This discussion is indicative of the fact that our present design problems require much information that a few years ago would have appeared almost academic. But also in the field of fabrication, and particularly in forming, do we find the necessity for establishing new criteria and standardized empirical tests. Here more than in structural design is there practical use for the complete stress-strain curve of a material, since most forming operations require working a material in its plastic range. The shape of this curve, as well as the numerical values of stress and strain obtained from it, are of great practical importance. If the stress-strain curve of one material shows a long, fairly steep slope from the yield point to the ultimate, its fabricating properties are quite different and at least for stretching operations, better than those of a material where the slope of the curve in this range is flat; the first material is stable and the second unstable.

Perhaps the material property with regard to which there has been the most change in thinking is elongation. It was about four years ago that the Production Research group at Lockheed printed accurate coordinate grids on tensile specimens and discovered the arbitrary nature of the standard criterion for elongation. They found that over short gage lengths the percentage elongation for some materials was two or three times that over a 2 in. gage length. It was also discovered that there was a good correlation between this information and the strain obtained without fracture on sharp bends, a phenomenon previously not explainable. This work was later taken up by O. A. Wheelon of Douglas, who carried the investigation further and set up the criteria of elongation for zero gage length; that is, the elongation occur-

ring in the most strained fiber in the necked portion of a tensile specimen. Further work by Mr. Wheelon confirmed the correlation between zero gage length elongation and forming operations involving large local deformations. It was shown that, even though materials might have the same elongation in 2 in. their zero gage length elongation might be quite different, with different forming properties. Fig. 3 indicates this characteristic.

Recent work has been done on the effect of elongation with gage lengths up to 100 in. This work has indicated that there is a radical reduction in the maximum elongation over such lengths. For example, 24ST with an elongation of 16 percent in 2 in. may have an elongation of less than 5 percent over 100 in. or over 40 percent in 0.01 in. The elongation over long gage lengths is of great importance in operations involving stretching long lengths of material. It was also discovered at both Lockheed and Douglas that the width of specimens had a marked effect on the elongation. Wide specimens showed a considerable reduction in elongation due to the fact that they were not free to contract laterally in accordance with Poisson's ratio. It is clear that research along these lines has added much to our understanding of forming problems, has explained many hitherto little understood phenomena, and has enabled analytical prediction of the approximate limitations to be expected with different materials subjected to various types of deformation.

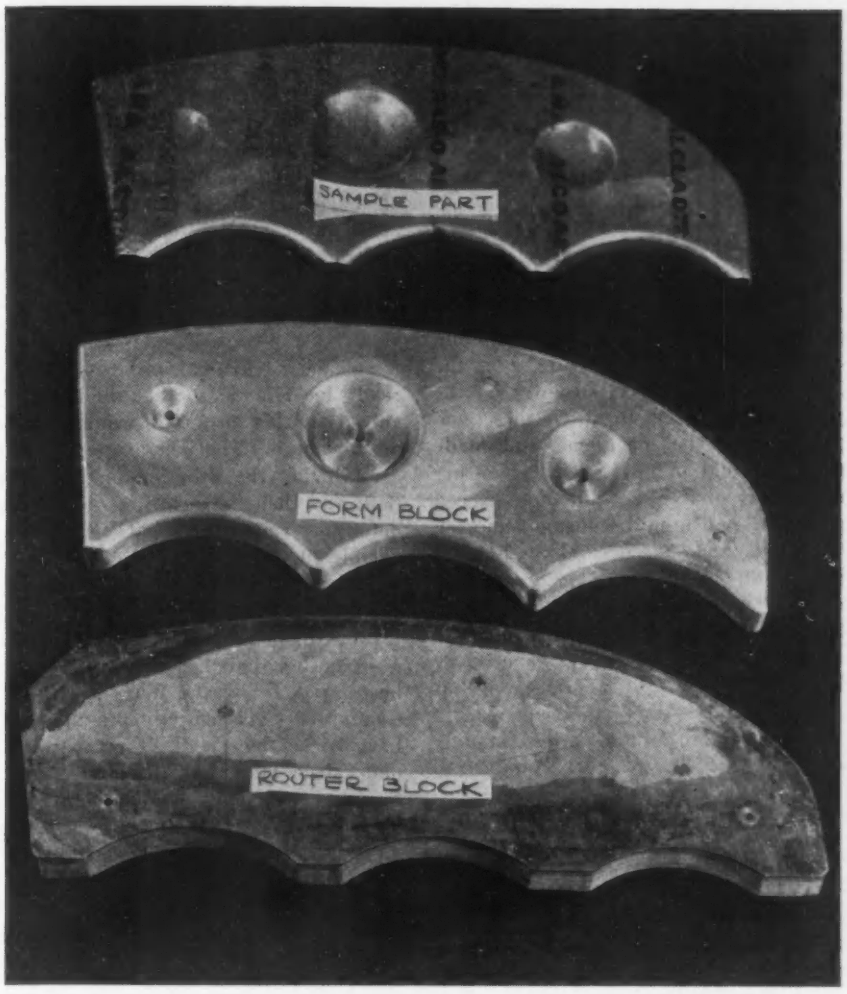


Fig. 4—Douglas standard hydropress test form block is used to determine percent deformation and spring-back of various tempers and gages of a material.

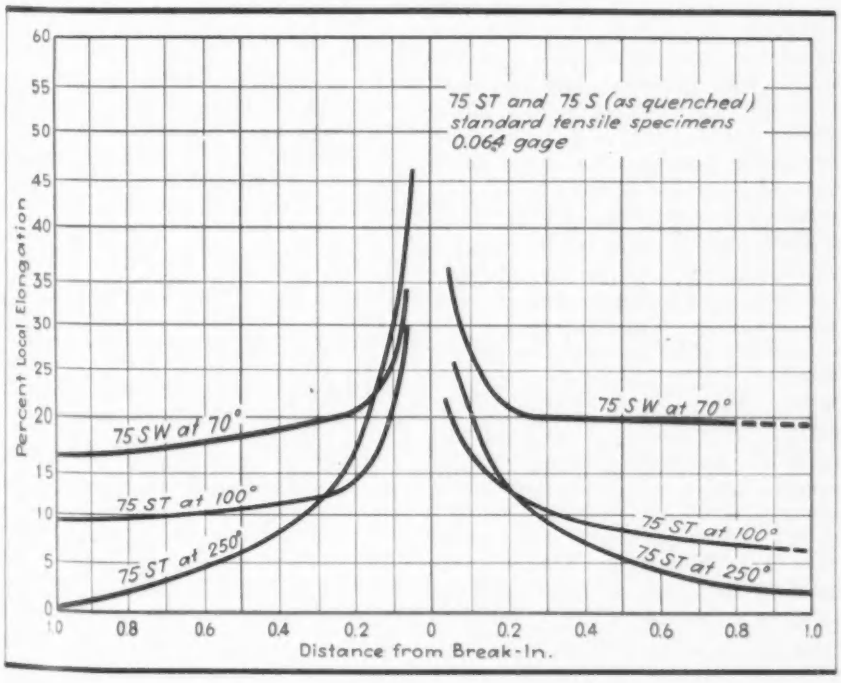

75 ST and 75 S (as quenched) standard tensile specimens 0.064 gage
Percent Local Elongation
Distance from Break-In.
75 SW at 70°
75 ST at 100°
75 ST at 250°
75 S W at 70°
75 ST at 100°
75 ST at 250°

Fig. 3—Elongation curves for 75S sheet. High uniform elongation 75SW indicates its excellence for stretching operations, while 75ST at 250 deg. F. is poor for stretching and excellent for operations requiring high elongation.

The prediction of the limits of formability of a new material on the hydropress is difficult by analytical means, involving as it does the capacity of a material to shrink. However, considerable practical, and almost quantitative information, can be obtained through use of a simple standard form block, Fig. 4, in which are incorporated both shrink and tension flanges as well as straight flanges. The curved flanges can have varying curvature so that a good determination can be made of the percent deformation to be expected. Such a specimen also lends itself to determination of spring-back. These data may be quickly obtained for various gages and tempers of a material.

The term, biaxial loading, is a relatively unfamiliar one and yet the phenomenon is one of much practical importance, since many formed parts are subjected to tensile stresses at right angles to each other. When this occurs, the limiting strain at fracture is reduced to approximately half its normal value with uniaxial loading. Variation in behavior of materials subjected to bi-

axial strain would therefore have a marked effect on their formability in many instances, and a knowledge of this variation is therefore necessary if we are to know the fabricating limitations of a material.

One other comment on these properties is made in order to show the importance of accepted data based on quantitative standard tests if we are to have economical production. This point is with reference to the best cutting speed for machining aluminum alloys. A number of years ago, the Aluminum Company discovered the phenomenal speed at which these materials could be machined, and made the information available. Cutting speeds at that time did not exceed 7,500 ft. per min. because of inertia, tradition, and absence of high-speed equipment. Under pressure of war conditions, however, it was rediscovered that it was possible to machine the strong aluminum alloys at speeds as high as 18,000 ft. per min. and that the optimum speed was about 14,000 ft. per min., thus approximately doubling previous production rates.

Need for Definitions

It is realized that many of the items given in the check list are relatively new. They not only lack definite definition, but even the need for them has not received general recognition as yet. Naturally, there has been no agreement on the detailed methods for determining the criteria. Yet, before the full benefit of recent material research and production developments can be attained, there must be cooperation in deciding first, what criteria are felt to be useful; second, definitions for the criteria; and third, specifications for making the tests to determine the criteria. Until this is done, no producer of a material can reasonably be asked to supply information for more than the conventional properties, nor can the present duplication of effort in the various laboratories be avoided.

The check list as given in this article was brought to the attention of the Engineering Committee of the Western Aircraft War Production Council. There was discussion and general agreement as to the desirability of the program necessary to make it effective. Consideration was also given to the participation of the American Society of Testing Materials in assisting in the development of standard test methods. However, no positive action has been taken to date. Unfortunately such a program, while it is of rather obvious long range value, cannot be given a high priority owing to the necessities of current work. Nevertheless, the fact must not be overlooked that the successful completion of the project would save its cost many times over in at least major elimination of duplication of laboratory work. Probably a much greater though indirect saving would result through a better understanding of basic material characteristics as these affect design, tooling, and fabrication.

Proposed Program

Sufficient technical progress has already been made so that the work involved in this program would not be unduly large. The primary need is for crystallizing the thinking on the question, and then the drafting of concrete definitions and specifications. When completed, these could be circulated to the various companies, material suppliers, and technical societies for approval or constructive comments. It is suggested that the initial work could best be done by the War Metallurgy Committee since many of their projects have been concerned with research on materials. These have been carried out by able technical men who are not only familiar with the properties of materials, but their use by industry.

A Materials Handbook

The next problem is that of systematizing and organizing all material information for use by design, material, and process engineers, tooling and manufacturing operation planners, inspectors, and those in purchasing and stockroom departments concerned with materials. In most companies at the present time, material data are scattered through at least half a dozen diverse publications, with a resulting difficulty in keeping information up to date and obvious inefficiency in securing needed data. In the April, 1944 issue of *Mechanical Engineering* appeared a most constructive article on this subject by S. B. Ashkinazy, materials and process engineer of the Sperry Corporation. This article outlined the manner in which for a number of years the Sperry Company has organized their material information in a materials handbook used by all divisions of the company concerned with materials. A section is devoted to each material and is arranged in standard form, giving many of the items included in the Douglas check list, Table I, and in addition pertinent government and industry specifications and preferred vendors.

The preparation of a similar materials handbook, including the information on recently developed materials, and for all materials the new data and criteria which are proving so valuable in predicting strength and fabricating characteristics, is the next essential step. For any one organization to compile such a handbook, except over a period of years, would be impracticable, valuable as it might be. On the other hand, after agreement has been reached on desirable criteria, with accepted definitions and methods of test, completion of such a book through cooperative effort would so distribute the work as not to impose an undue burden on any organization. Appropriate allocation of the work on one or two materials to each of a large number of organizations, including vendors as well as users, could quite possibly be organized. Provision would have to be made for review by a competent technical group of the work done by individual companies so as to insure technical correctness and uniformity of the presentation. When completed, a materials handbook of this nature would be of inestimable value to all industry.

A few sections of such a handbook would undoubtedly have to be modified by most companies owing to variation in fabricating practices, but this would be a relatively simple task. Material suppliers would gain much from participating in a cooperative venture of this nature and from supplying for new materials many of the more important and fundamental data and criteria. Once suppliers are familiar with the tests, the important ones could quite simply be performed during the course of development of a material, and might often materially assist in its development through bringing to light deficiencies that frequently do not appear until discovered by the user.

It is hoped that this article may stimulate thinking on the question of organizing our knowledge of materials, and of establishing a common language so that criteria and data, obtained by any laboratory, can be understood and accepted by all, in the same manner that conventional data are now accepted. Thus would be brought to practical fruition another cooperative effort of industry which in the postwar period will result in more efficient use of materials from both design and fabricating viewpoints.

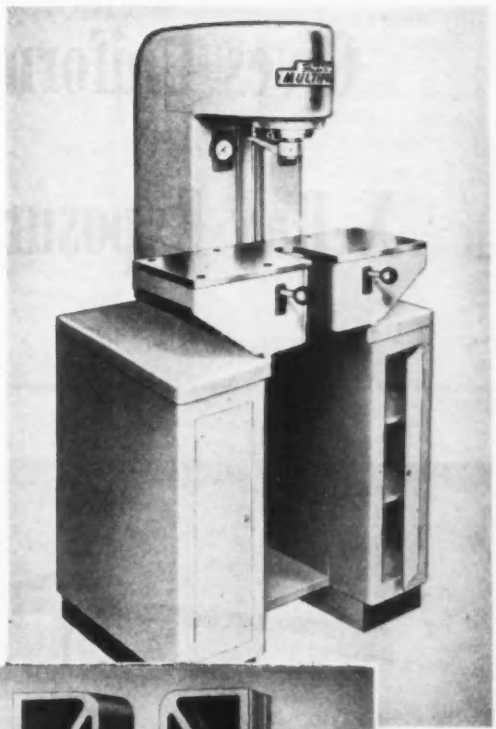
A fitting conclusion to this article is a sentence taken from a paper on the development of plastic materials delivered at the recent fall meeting of the Society of Automotive Engineers by Major Russell Houghton of Wright Field: "The day is gone beyond recall when we may do things just simply hoping for the best. We must know exactly why we are doing them, as far as the resources of science can tell us, so that we may control our manufacturing materials and not they us."

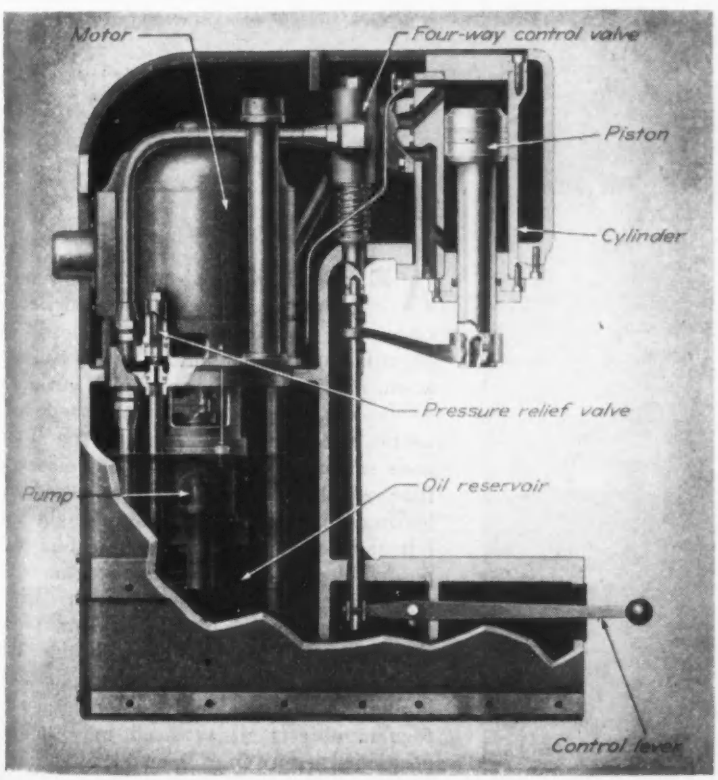
NEW DESIGNS

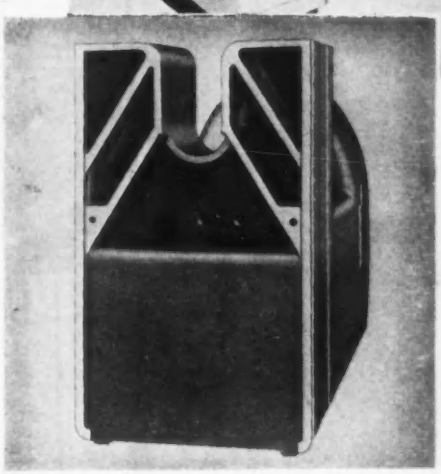
of Present and Postwar Products

Bench Press Has Adjustable Hydraulic Control

STROKE is adjustable between 6-in. maximum and ⅛-in. minimum and ram pressures are controllable between 300 and 8,000 lb. in a new hydraulic bench press, developed by the Denison Engineering Company. Controls are so designed that ram speed can be adjusted from a maximum of 200 to a minimum of 20 in. per min. The frame of the press is a one-piece casting, with heavy sidewall reinforcements, webs and cross-members, into which the hydraulic units are assembled.



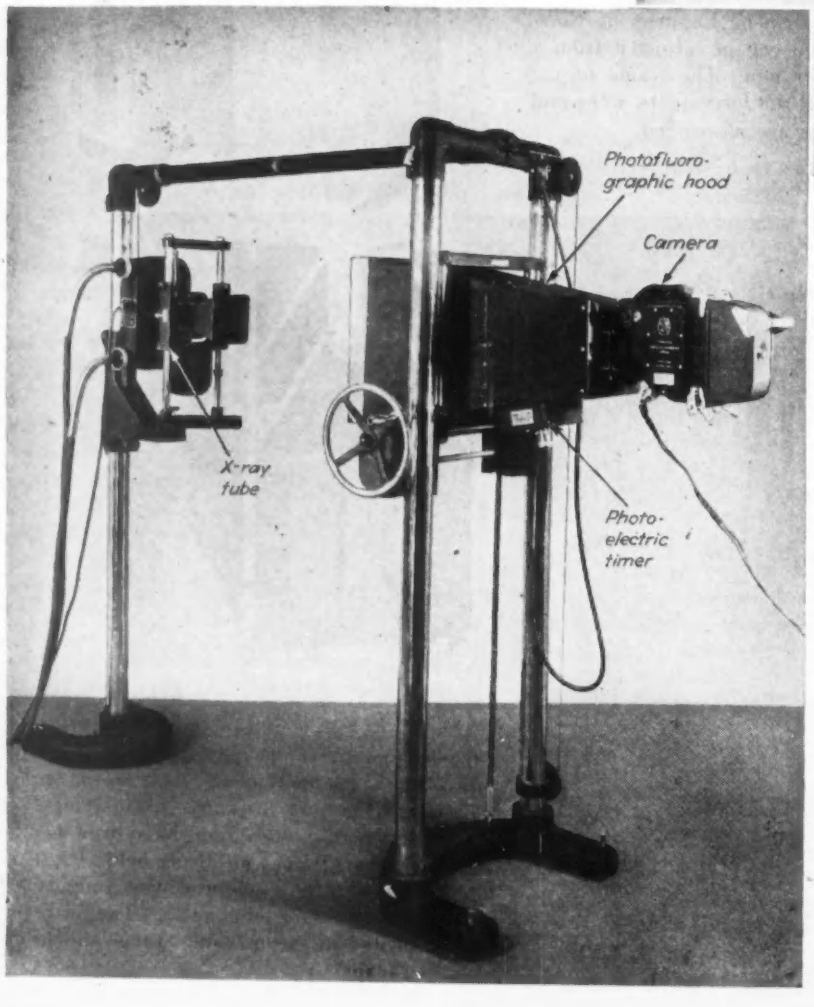




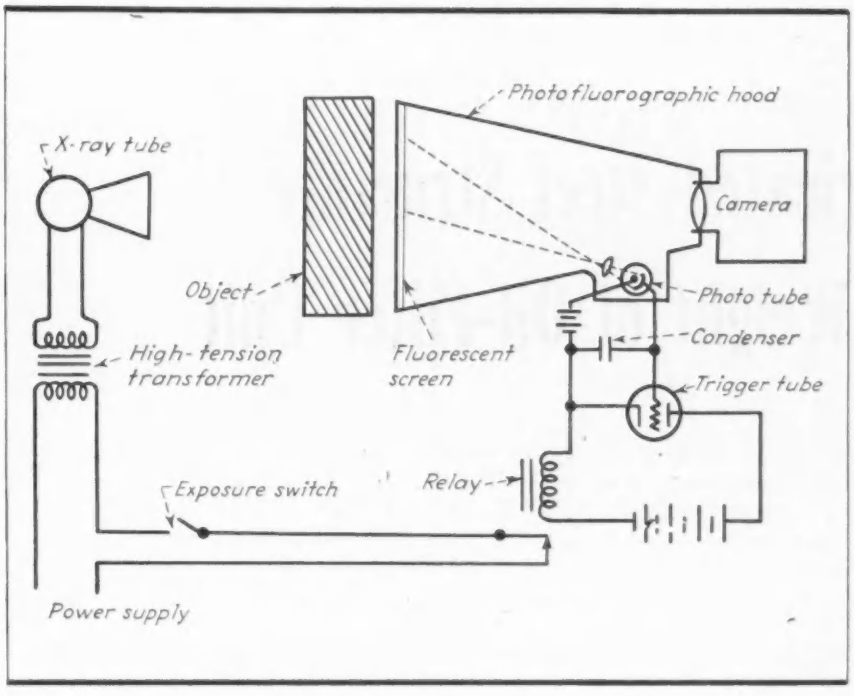
Two levers are connected to the four-way valve controlling ram movement. Release of either lever stops the ram instantly, while release of both levers causes the ram to return to the upper limit, where it is positively held. Pressure is maintained by a motor-driven submerged pump and a pressure-relief valve. The oil reservoir is located in the machine frame and has a ten-gallon capacity.

Electronic Timer Gives Uniform X-Ray Exposures

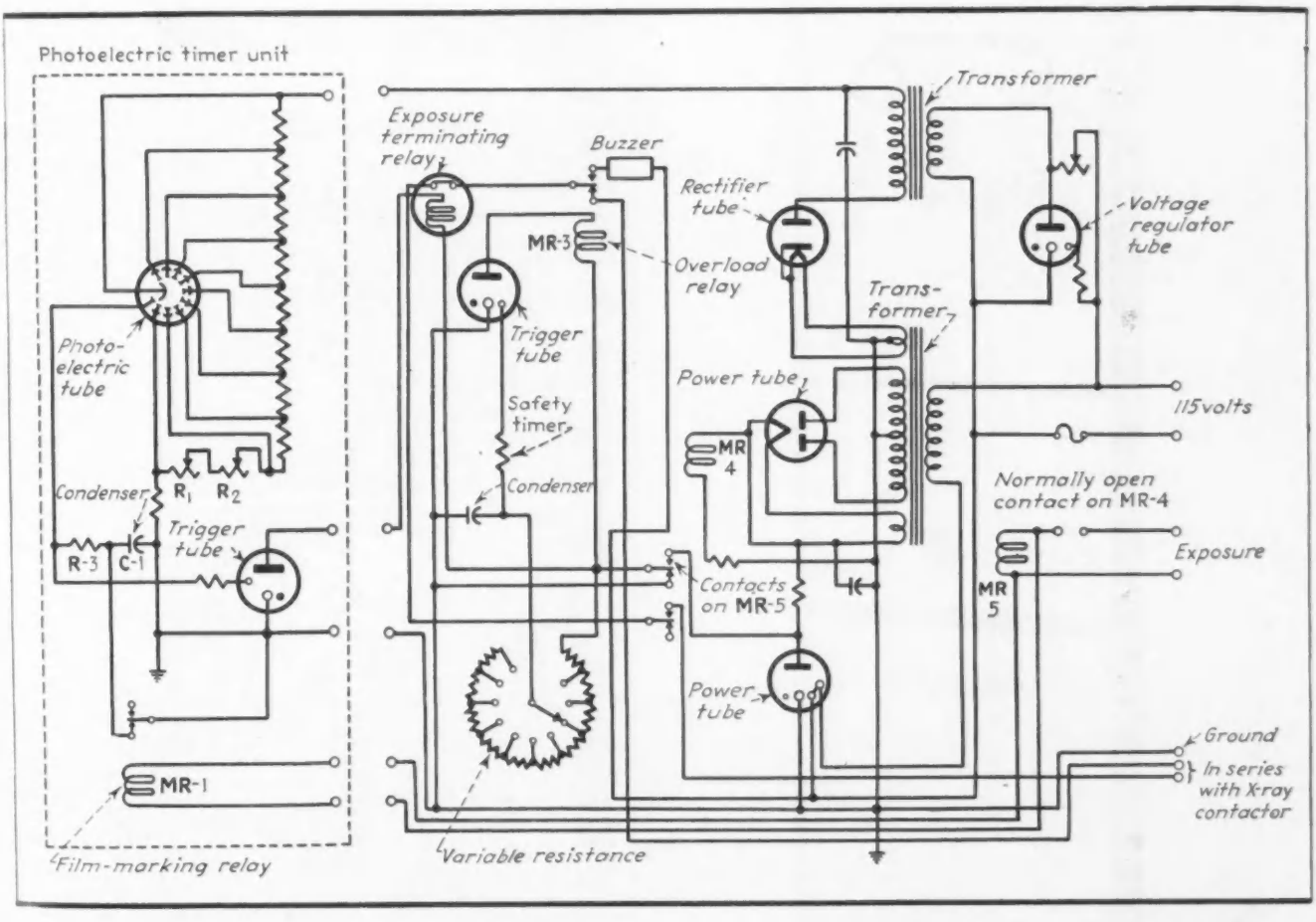
PHOTOELECTRIC TIMER



A PHOTOELECTRIC device, for timing of X-ray exposures, has been developed by the Westinghouse Electric & Manufacturing Company. The X-ray radiation, passing through an object, strikes a fluorescent screen and is converted into visible radiation. A section of the luminous screen is scanned by a photoelectric tube which in effect measures the light leaving the screen. When enough light has left the screen for the desired film exposure, the photo-electric timer actuates a relay and opens the X-ray circuit. First used in medical radiography for mass chest surveys on miniature roll film, the development will find general application in industrial X-ray analysis for large irregular objects which need only to be positioned before the screen.



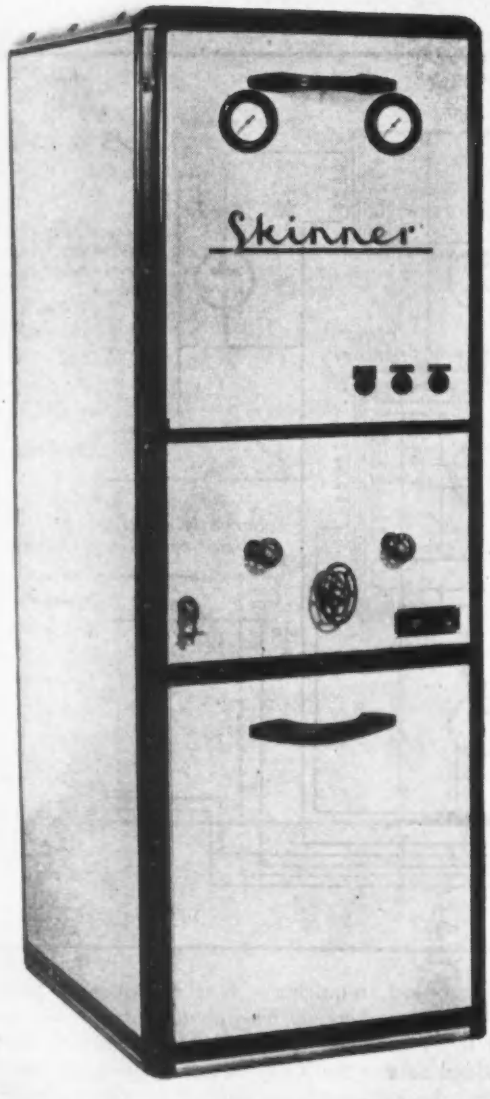
Electronic timer consists primarily of a multiplier-photoelectric tube and a condenser-thyratron-relay system. When the exposure switch of the X-ray unit is closed, the X-ray tube circuit is energized and X-rays pass through the object positioned before the photofluorographic hood, and the fluorescent screen converts the X-rays into light. Light on the fluorescent screen is then focused by a lens on the cathode of the photoelectric tube. The light entering the photoelectric tube initiates a small current proportional to the light intensity of the scanned section of the fluorescent screen. This current charges a condenser and produces a potential which increases as the collected charge increases. The condenser voltage is impressed across the grid and cathode of a trigger tube and fires the tube, when the necessary ionization is created, energizing a magnetic relay which opens the X-ray circuit and terminates the exposure of the film.

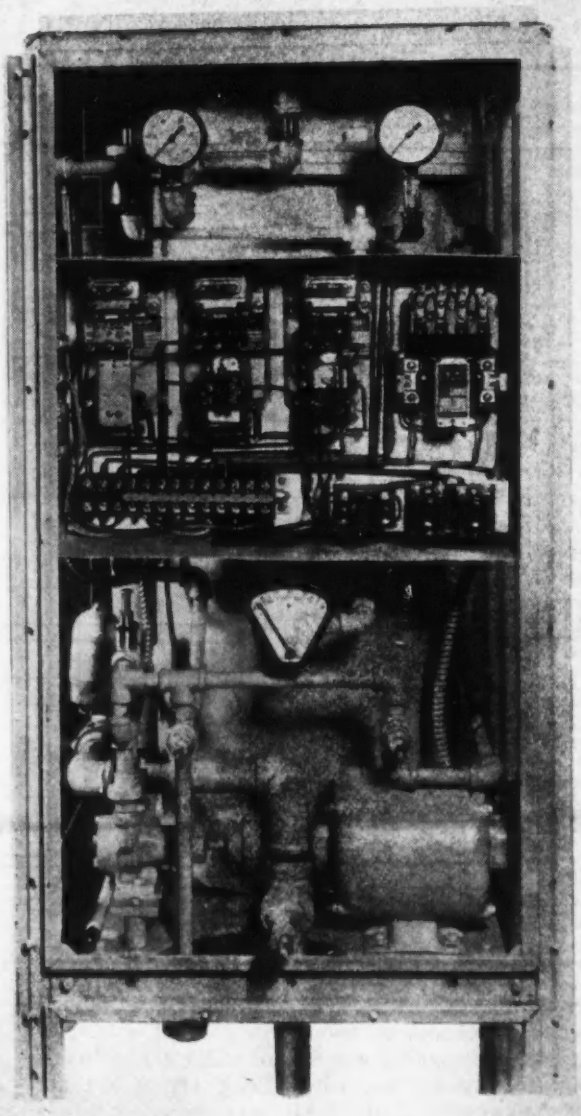


A safety timer, consisting of a trigger tube, an adjustable resistance, a condenser, two relays, and a buzzer, protects the X-ray unit against any failure of the photoelectric timer unit and against excessively long exposure times exceeding the capacity of the X-ray tube, as might result when a dense object, requiring a long exposure, is placed before the fluorescent screen. The photoelectric timer unit is designed to be attached to the photofluorographic hood and is an added unit to the X-ray circuit. Density of the exposed film can be adjusted by a control on the timer unit.

Prefabricated Steel Structure Supports Weight of Oil-Filter Unit

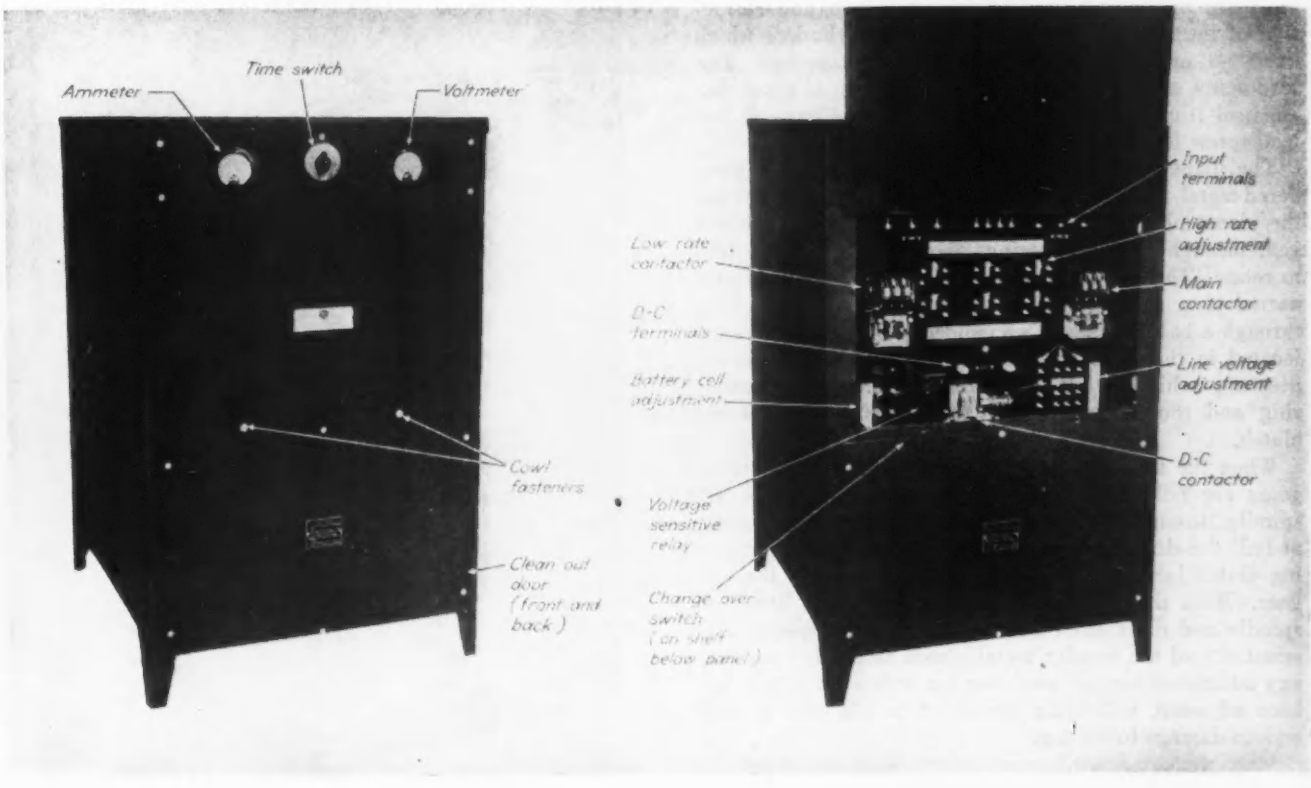
LIGHT-STEEL Lindsay structure supports the entire weight of the equipment in a compact oil filtering unit manufactured by Skinner Purifiers, Inc. The unit circulates oil continuously to remove moisture, sludge and dirt. The filter design includes provision for an electrically controlled and timed back-wash action in which reverse flow of clean oil and air removes dirt that has accumulated on the outer edges of the filter elements. The dirt collects in a drain and can be removed as necessary.





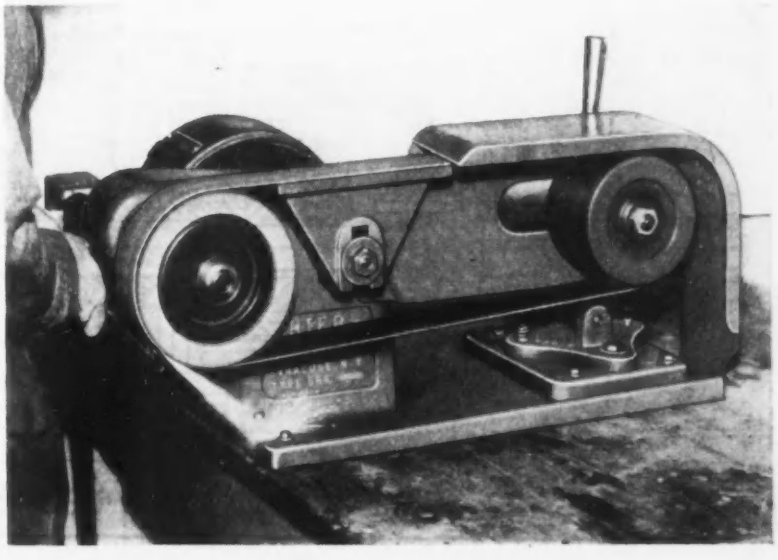
Charger for Electric Truck Batteries

LARGE-CAPACITY, automatic copper-oxide battery charger built by General Electric, capable of charging 30 nickel-alkaline or 24 lead-acid battery cells, features simplified controls and a d.c. contactor. The internal control panel is laid out to simplify adjustments. Nameplates indicate methods for changing the charging rate, adjustment of line voltage and battery-cell adjustment. The d.c. contactor prevents batteries from discharging back through the charger after the a.c. has been turned off or fails. The charger automatically shuts off when the charge is completed, but it can be stopped manually before the charge is completed. The unit operates on 3-phase power.



Bench Belt Grinder Has Variety of Uses

Versatility of operations was the design objective in a bench belt grinder made by Porter-Cable Machine Company. Work can be held against the belt as it passes over the forward contact roll or platen. If desired, the platen can be turned downward and work held against underside of belt. A wire brush and other attachments can be fastened to forward contact roll for deburring operations.

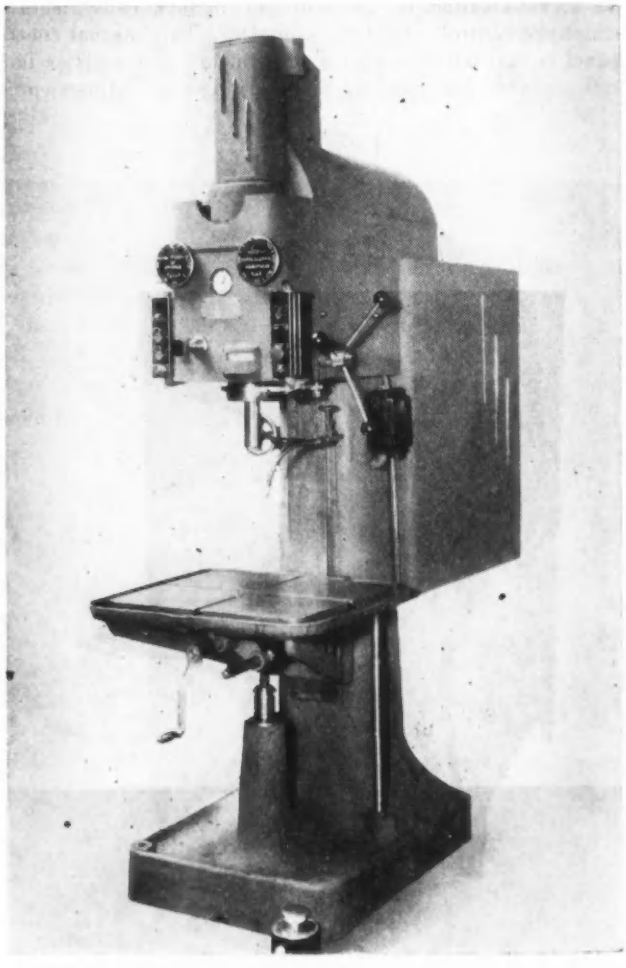


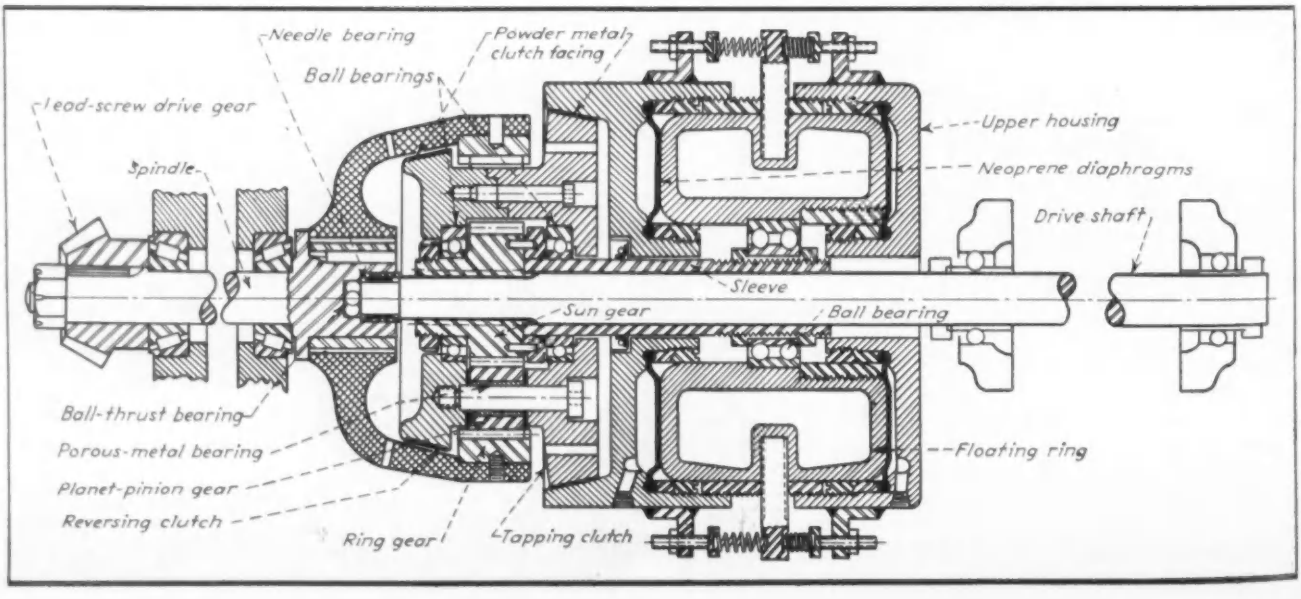
Pneumatically-Controlled Planetary Mechanism Drives Spindle

DRIVING and reversing of the tapping spindle is accomplished through a planetary and clutch mechanism in a new machine developed by Cleveland Tapping Machine Co. Powdered-metal faced clutches, air controlled, give precise adjustment of vertical travel to within 0.005 in. limits. Rotation of the spindle can be held to one-tenth of a revolution. Rapid approach and retraction of the spindle is done with two air cylinders which exert no pressure on the spindle when tapping. The lead screw assembly is so constructed that it is never disengaged from the spindle. A locking device engages the lead screw for positive positioning.

The planetary drive is operated by two opposed, powdered-metal faced, cone clutches which act as a spider for the planet pinion gears. Clutches are clamped to the sun gear through two ball bearings about which they are free to rotate. The sun gear, splined to the drive shaft, is connected to a sleeve which is fastened to a floating ring through a ball bearing. Two molded neoprene diaphrams, located in the upper housing, are so positioned that air pressure behind either diaphram will move the floating ring and thus engage either the tapping or reversing clutch.

When the tapping clutch is engaged the planet pinion gears are held stationary and the sun gear drives the spindle, through the planetary pinion gears and ring gear, at half the drive shaft speed. Engagement of the reversing clutch locks the planetary pinion gears and the sun gear. With these parts operating as a locked unit, the spindle and drive shaft operate at the same speed. The sensitivity of the powder metal clutch facing is such that any additional torque, over that for which the clutch has been adjusted, will cause the clutch to slip and prevent serious damage to the tap.





Regional Research Laboratories

WATER is wet and if it weren't so, it wouldn't be water. As an analogy, "big corporations" have large research laboratories that discover or develop new materials, products and processes. If it weren't so, such corporations would not be "big corporations" and there would be a dearth of discoveries and developments. Conversely, if the corporation is not big it is not able to spend millions a year for research, and thereby finds itself at a distinct disadvantage in competition with the big corporations.

Industrial activities during the war brought into prominence the handicaps of the smaller manufacturers resulting from their lack of research facilities. In tune with the trend of the times, it was suggested that the federal government build product research laboratories and conduct them solely for the benefit of small manufacturers. Another suggestion was that the federal government sponsor and pay the costs of product development and of research projects requested by small manufacturers, the actual work to be done by commercial and university laboratories. The most extreme proposals, embodied in bills presented before the last Congress, went so far as to demand government ownership of all patents.

Proponents of such measures point to the success of the government sponsored research by industry on war equipment and devices, the accomplishments of the Office of Scientific Research and Development, and similar records. They fail to realize the vast difference between a "war economy" and a "peace economy." War goods are not commercial products. There is only one customer for them. Industry does the development and research for the customer and the customer pays for it.

What appears to be an excellent solution to the problem of research for the smaller manufacturer is found in the rapid expansion of regional research laboratories of the character of Mellon Institute, Battelle Memorial Institute, Ohio State Research Foundation, and the Armour Institute Research Foundation. A more recent addition is the Southern Institute of Industrial Research, the announced purpose of which is to develop products and materials that can be produced most advantageously in the South. Similar laboratories have been proposed for Southern California.

Aside from all the obvious superiorities that such regional laboratories have over government agencies, they build a community of interest among the industries of the region, they stimulate progress in technological developments, and they bring social benefits to the people.

Small and medium-sized manufacturers should cooperate toward the establishment of more regional research laboratories. Obviously many more such laboratories could be put into profitable operation for the benefit of manufacturers in the region.

G. F. Rodenbolt

Kinetic Energy in Flywheels Calculated by an Exact Method

HENRI LEWIN
Chief Engineer, Brown-Boggs Foundry & Machine Company, Ltd.

Development of equations for the kinetic energy in rotating solids which are geometric bodies of revolution with particular reference to component parts of press flywheels. Exact equations for the energy are compared with the conventional approximate formula to show degree of error involved. Several problems are solved to show application procedure.

CALCULATING exactly the energy stored in a revolving flywheel for a press appears to be a difficult task. On presses when flywheels are too heavy, the results are often disastrous. Broken crankshafts and even press frames are often caused by too much energy being stored in flywheels.

Approximate or empirical formulas are unsatisfactory for use in designing press flywheels. Three main reasons are responsible for this:

1. Such formulas usually assume that the flywheel is reduced to its rim only, thus neglecting the web and hub, the energy of which is not negligible in press flywheels.

2. Even for the rim alone these formulas give an inexact value of the stored energy. They assume that the mass of the flywheel is concentrated at a distance from the center equal to the mean radius of the rim. This is obviously not correct, since the energy varies proportionately to the square of the velocity, that is, to the square of the radius. Furthermore, there is no method of appreciating the degree of approximation of the energy thus found.

3. Formulas of the form $WV^2/2g$ can be used practically only to verify the energy of an existing flywheel. They involve a knowledge of the weight of the rim as well as of its mean velocity. While these data can be easily found for an existing flywheel, they are precisely the unknowns of the equation by means of which a new flywheel has to be calculated.

To overcome these difficulties, it has been deemed necessary to present simplified formulas in many handbooks along with the $WV^2/2g$ formulas. The simplified formulas, while easy to handle and to apply, present the grave inconvenience common to most empirical formulas of being undependable and uncontrollable.

That the necessity for a better and more dependable means of calculating press flywheels has been recognized, is evident from the numerous articles which periodically appear in the technical press on this subject.

Consider a flywheel for which the kinetic energy is to be calculated. With

M = mass of the body, lb. per acceleration of gravity
v = velocity of the body, in per sec.
E = Kinetic energy stored in the body in. lb.

The general expression for the kinetic energy of a moving body is

$$E = Mv^2/2$$

The expression for the kinetic energy of a revolving body, in which I is the moment of inertia for the mass M about the axis of revolution, and ω is the angular velocity in radians per sec. of the mass about the axis of revolution, is

$$E = I\omega^2/2 \qquad (1)$$

A press flywheel of the conventional design can be divided into three component parts: Rim, web, and hub. Each of these is a body of revolution. Thus for each, the volume and consequently the mass, and the moment of inertia of this mass with reference to its axis of revolution can be calculated by applying the second theorem of Guldinus.

For the general case, let the cross-sectional view shown in Fig. 1 represent a body of revolution.

A = area of cross-section
zz = axis of revolution of body
aa = axis passing through center of gravity of area A and parallel to zz
R_1 = distance between axes aa and zz
w = specific weight of the material of which the body is composed, that is, weight of a unit of volume of this material (not to be confused with specific gravity)
g = acceleration of gravity
M = mass of body
i = moment of inertia of area A with reference to axis aa
I = moment of inertia of the mass of the body with reference to its axis of revolution zz

Moment of inertia of the body with reference to the axis of revolution

$$I = \frac{w}{g} 2\pi R_1 (AR_1^2 + 3i) \qquad (2)$$

Mass of the body

$$M = \frac{w}{g} 2\pi R_1 A \qquad (3)$$

Then from Equations (2) and (3)

$$I = M(AR_1^2 + 3i)/A \qquad (4)$$

In the flywheel shown in Fig. 2, the rim, web and hub are each formed by revolving a rectangular cross-section about the axis.

Let R = outside radius of one of the bodies concerned
r = inside radius of the body
h = length of the body parallel to the axis zz

Then

$$R_1 = (R + r)/2 \qquad (5)$$
$$A = (R - r)h \qquad (6)$$

For a rectangle, the moment of inertia of its area with reference to an axis passing through its center of gravity and parallel to one side of the rectangle is

$$i = \frac{(R - r)^3 h}{12}$$

Substituting these values of R_1, A and i in Equation (4)

$$I = M(R^2 + r^2)/2 \qquad (7)$$

Furthermore, substituting in Equation (3) the values for R_1 and A given by Equations (5) and (6)

$$M = \frac{\pi hw}{g} (R^2 - r^2) \qquad (8)$$

Substituting this value of M in Equation (7)

$$I = \frac{\pi hw}{2g} (R^4 - r^4) \qquad (9)$$

With the angular velocity ω equal to $2\pi n$, where n is the number of revolutions per sec. of the flywheel, and substituting the value of ω^2 *and* I in Equation (1)

$$E = \frac{\pi^2 hw}{g} (R^4 - r^4) n^2 \qquad (10)$$

Setting p equal to the ratio h/R, and q equal to the ratio r/R, Equation (10) becomes:

$$E = \frac{\pi^3 n^2 w}{g} p (1 - q^4) R^5 \qquad (11)$$

For flywheels made of cast iron, the specific weight w equals 0.26 lb. per cu. in. Substituting this value in Equation (11) and using the value of g equal to 386.22 in. per sec. per sec., the value of the kinetic energy of a part of a flywheel will be

$$E = 0.0209 n^2 p (1 - q^4) R^5, \text{ in. lb.} \qquad (A)$$

in which R is expressed in inches, and p and q are abstract numbers.

For steel flywheels having an average specific weight w of 0.28 lb. per cu. in. Equation (11) becomes

$$E = 0.0225 n^2 p (1 - q^4) R^5, \text{ in. lb.} \qquad (B)$$

These formulas can be used to calculate the energy of any part of the flywheel that has a rectangular cross-section.

Where E_1 is the energy of the rim, E_2 the energy of the web and E_3 the energy of the hub, the total energy of the flywheel will be

$$E = E_1 + E_2 + E_3$$

When the web of the flywheel is shaped like a frustum of a cone, and a fair approximation of the energy of the web is sufficient, the energy of the web can be obtained by assimilating the frustum of the cone to a cylinder of the same diameter and corresponding height.

When an approximate value for the energy is not sufficient, a special calculation must be made for the conical web. An exact and handy method for the calculation in this case will be given later.

A comparison will now be made between the conventional formula and the one here derived.

Let e denote the energy of the flywheel as calculated by applying the conventional formula, in which W is the weight of the rim, V the linear velocity at its mean radius, and g the acceleration of gravity, then

$$e = WV^2/2g \qquad (12)$$

Substituting in Equation (12) the mass M of the rim for W/g, and for

$$V^2 = \left[2\pi \left(\frac{R + r}{2}\right) n\right]^2 \qquad (13)$$

$$e = M \pi^2 n^2 (R + r)^2/2 \qquad (14)$$

Substituting in Equation (1) the value $2 \pi n$ for ω, and for I the value given by Equation (7)

$$E = M (R^2 + r^2) \pi^2 n^2 \qquad (15)$$

Subtracting Equation (14) from Equation (15),

$$E - e = M \pi^2 n^2 (R - r)^2/2 \qquad (16)$$

Since the right side of this equation contains beside M, which is always positive, three squares π^2, n^2 and $(R\text{-}r)^2$

$$E - e > 0, \text{ therefore } E > e \qquad (17)$$

This proves that the value of the kinetic energy of a flywheel as obtained by applying the conventional formula is always smaller than the actual energy of the rim alone.

Thus it becomes obvious that the danger of applying the conventional formula for flywheel calculation is twofold. First, the energy of the web and the hub is neglected; and second, the energy obtained is always too small, even when the energy of the rim alone is being considered. If the conventional formula is used, it is easy to understand why crankshafts and frames of power presses break so frequently even in machines of excellent make.

It may be interesting to know the limits of the error which is liable to be committed when applying the conventional formula to find the energy of a rim alone of a given outside radius R. For this purpose, divide Equation (14) by Equation (15), then

$$\frac{e}{E} = \frac{1}{2}\left(1 + \frac{2Rr}{R^2 + r^2}\right) \qquad (18)$$

Since R and r are both positive, the minimum value which can be attained by the fraction $2Rr/(R^2 + r^2)$ is zero and this is obtained for r equals zero. Introducing zero for the value of r in Equation (18)

$$e/E_{min} = 0.5 \qquad (19)$$

The maximum value which can be attained by the fraction $2Rr/(R^2 + r^2)$ is reached when $(R^2/r) + r$ has its minimum value. The condition for this minimum value is found by taking the first derivative of the function

$$f(r) = \frac{R^2}{r} + r \qquad (20)$$

and equating it to zero. This condition is satisfied when r equals $\pm R$.

Substituting this in Equation (18)

$$e/E_{max} = 1 \qquad (21)$$

Thus it is evident that the use of the conventional formula is most dangerous when r is small in comparison with R, the error being susceptible of attaining the limit of 100 percent for a flywheel taking the shape of a solid cylinder. Such conditions are frequently approached in small flywheels revolving at high speeds.

On the other hand, it is evident that the error involved may be neglected when r is nearly as great as R. This means a flywheel the rim of which is thin as compared with its outside radius. It is worth noting that while such a condition is often realized in large fly-

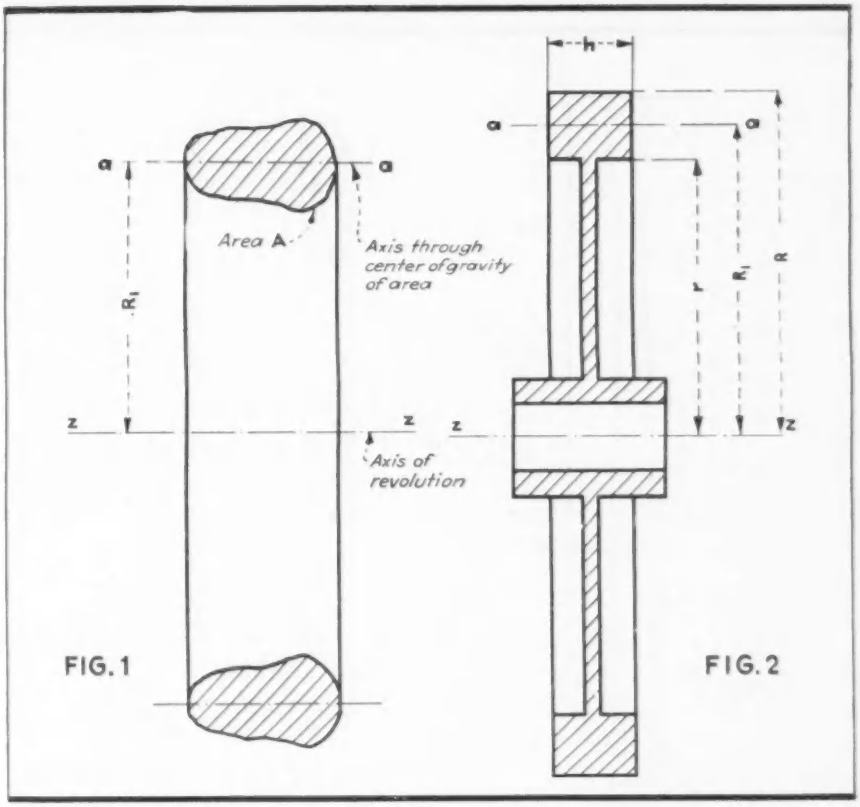


FIG. 1

FIG. 2

Fig. 1—Geometric body formed by revolving a plane surface about an axis. Fig. 2—Flywheel in which the rim, web and hub are each formed by revolving a rectangular cross-section about an axis.

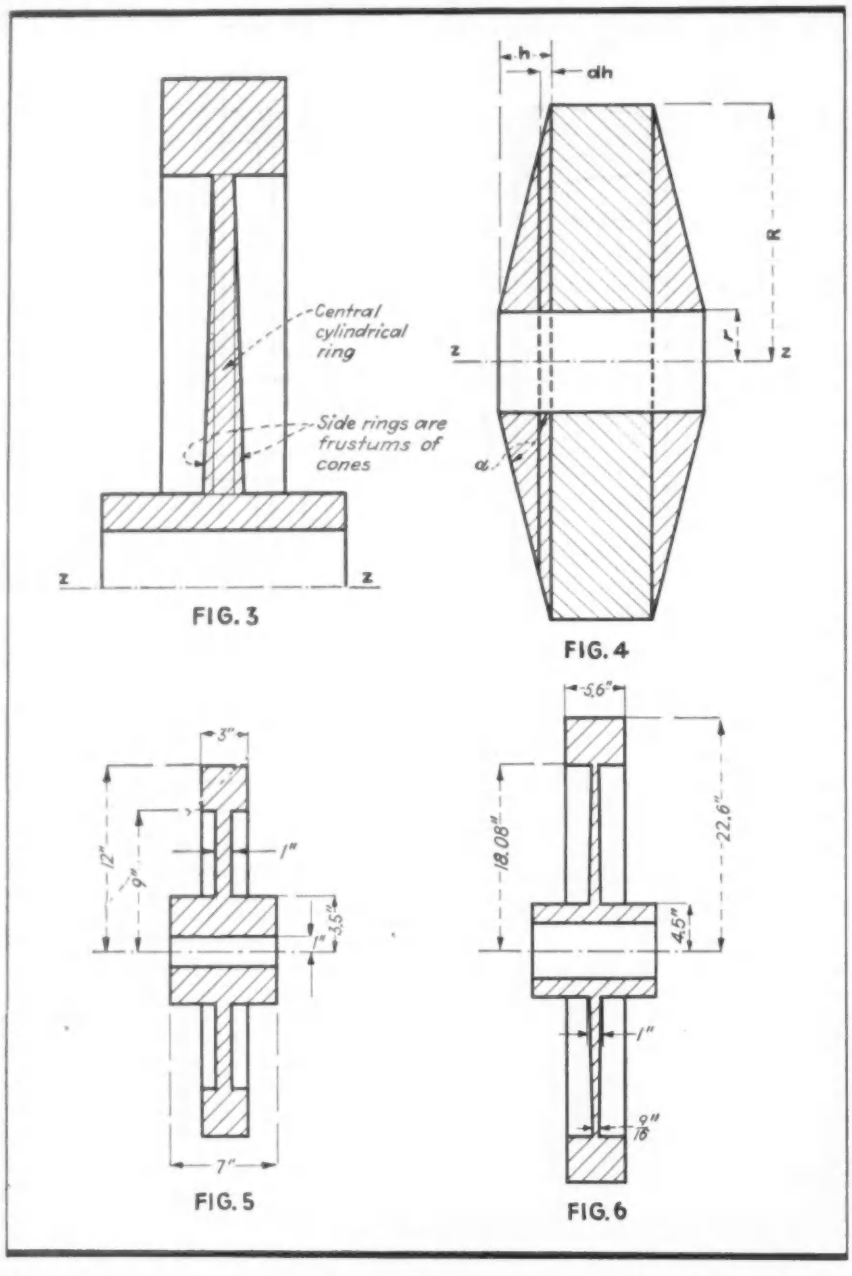


Fig. 3—Flywheel with tapered web. The web may be considered as composed of one central cylindrical ring and two side rings having the shape of a frustum of a cone. Fig. 4—Method of deriving the moment of inertia of a solid shaped like the frustum of a cone. Fig. 5—Cross-section of flywheel with dimensions for Problems 1 and 2. Fig. 6—Cross-section of a flywheel having a tapered web section with dimensions for Problem 6.

wheels for steam engines, but this condition is exceedingly infrequent in press construction.

The easiness and convenience of using Equations (*A*) and (*B*) could be increased by the adoption of standard ratios for the coefficients p and q. The adoption of standard coefficients would standardize the geometric shape of flywheels used in the manufacture of presses, as well as allow the designer to solve easily the four main problems of flywheel calculation which are encountered in practice. This assertion hardly needs to be proved since the main equation contains only one unknown quantity, R, the outside radius of the flywheel.

When calculating the energy of a tapered web, such as is shown in Fig. 3, the web may be considered as being composed of one central cylindrical ring and two side rings having the shape of a frustum of a cone.

The moment of inertia of an elemental part of infinitely small height dh of such a frustum can be derived by taking the derivative of Equation (9).

$$dI = \frac{\pi w}{2g}(R^4 - r^4)\,dh$$

which by integration from 0 to h gives

$$I = \frac{\pi w}{2g}\left(\int_0^h R^4 dh - r^4 \int_0^h dh\right) \qquad (22)$$

since r is a constant with reference to h.

From Fig. 4

$$R - r = h \tan \alpha \qquad (23)$$
$$R = h \tan \alpha + r$$
$$R^4 = (h \tan \alpha + r)^4$$

Substituting this value of R^4 in Equation (22), integrating, substituting for $h \tan \alpha$ its value as given by Equation (23), substituting qR for r, and observing that

$$1 + q + q^2 + q^3 + q^4 = \frac{1 - q^5}{1 - q}$$

Equation (22) becomes

$$I = \frac{\pi w}{10g}\left(\frac{1 - q^5}{1 - q} - 5q^4\right) hR^4 \qquad (25)$$

Again, from Equation (1) by substituting for ω^2 its value $4\pi^2 n^2$, and for I its value from Equation (25), and multiplying by 2 the energy E_2 for two frustums of the cones of the web is obtained

$$E_2 = \frac{\pi^2 n^2 w}{5g}\left(\frac{1 - q^5}{1 - q} - 5q^4\right) 2hR^4$$

in which $\pi^2 n^2 w/5g$ can be expressed as a single constant factor. Thus from a cast iron web

$$E_2 = 0.00418\, n^2 p \left(\frac{1 - q^5}{1 - q} - 5q^4\right) R^5 \qquad (C)$$

and for a steel web

$$E_2 = 0.0045\, n^2 p \left(\frac{1 - q^5}{1 - q} - 5q^4\right) R^5 \qquad (D)$$

When finding the total energy of the web, of course, the energy thus obtained is added to the energy of the central cylindrical ring found by applying Equation (*A*) or (*B*) respectively. To simplify calculations the author has prepared tables of the fourth and fifth powers of numbers from one to 999.

Problem 1. Find the energy stored in the cast iron flywheel, shown in Fig. 5, which revolves at 120 r.p.m. Assume that the energy of the rim alone is to be considered.

$$p = h/R = 3/12 = 0.25$$
$$q = r/R = 9/12 = 0.75$$
$$n = 120/60 = 2$$

From Equation (*A*) the energy will be

$$E = 0.0209 \times 2^2 \times 0.25\,(1 - 0.75^4) \times 12^5 = 3{,}555 \text{ in. lb.}$$

Problem 2. For the same flywheel used in Problem 1, find the total energy stored in the rim, web and the hub.

For the web

$$p_1 = 1/9 = 0.111, \text{ and } q_1 = 3.5/9 = 0.389$$
$$E_1 = 0.0209 \times 2^2 \times 0.111\,(1 - 0.389^4) \times 9^5 \doteq 538 \text{ in. lb.}$$

For the hub

$$p_2 = 7/3.5 = 2, \text{ and } q_2 = 1/3.5 = 2/7$$
$$E_2 = 0.0209 \times 2^2 \times 2\,[1 - (2/7)^4] \times 3.5^5 = 62 \text{ in. lb.}$$

Total energy will be

$$E = 3{,}555 + 538 + 62 = 4{,}155 \text{ in. lb.}$$

In this particular example the energy stored in the web and the hub represents 17 percent of the energy stored in the rim.

Compare these results with the energy obtained by applying the conventional formula

$$e = WV^2/2g$$
$$W = \pi h (R^2 - r^2) w$$
$$= \pi \times 3 (144 - 81) \times 0.26 = 154.41 \text{ lb}$$
$$V = 2\pi \left(\frac{R+r}{2}\right) n$$
$$= 2\pi (12 + 9) = 132 \text{ in. per sec.}$$
$$e = \frac{WV^2}{2g} = \frac{154.41 \times 132^2}{2 \times 386.22} = 3{,}479 \text{ in. lb.}$$

By dividing the correct value of the energy previously found by this latter one

$$\frac{E}{e} = \frac{4{,}155}{3{,}479} = 1.2$$

This shows that in the present example the exact amount of energy stored in the flywheel is 20 percent higher than the value which would have been expected had the calculation been made by applying the conventional formula.

Problem 3. What should be the outside radius of a cast iron flywheel revolving at 120 r.p.m. to store 72,000 in. lb. of energy, taking p equal to 0.25 and q equal to 0.8. Assume all energy is stored in the rim alone.

Solving the main Equation (A) for R and then evaluating

$$R = \sqrt[5]{\frac{E}{0.0209\, n^2 p\, (1 - q^4)}}$$
$$= \sqrt[5]{\frac{72{,}000}{0.0209 \times 4 \times 0.25\, (1 - 0.4096)}}$$
$$= 22.6 \text{ in.}$$

The inside radius r of the flywheel

$$r = qR = 22.6 \times 0.8 = 18.08 \text{ in.}$$

the width h of the face of the rim

$$h = pR = 22.6 \times 0.25 = 5.6 \text{ in.}$$

Problem 4. To what inside radius should the rim of the flywheel of Problem 3 be turned out to reduce the amount of energy stored in it to 60.000 in. lb.?

Solving Equation (A) for q and evaluating

$$1 - q^4 = \frac{E}{0.0209\, n^2 p R^5}$$
$$q = \sqrt[4]{1 - \frac{E}{0.0209\, n^2 p R^5}}$$
$$= \sqrt[4]{1 - \frac{60.000}{0.0209 \times 4 \times 0.25 \times 5{,}895{,}793}}$$
$$= 0.846$$

Thus the inside radius r will have to be

$$r = qR = 22.6 \times 0.846 = 19.120 \text{ in.}$$

Problem 5. What will be the face width of a steel flywheel to accumlate 120,000 in. lb. of energy when revolving at 180 r.p.m., assuming an outside radius R of the rim to be 12 in. and an inside radius r to be 10 in. The energy of the rim alone is to be considered for a first approximate calculation.

Solving Equation (B) for p and evaluating

$$p = \frac{E}{0.0225 n^2 (1 - q^4) R^5}$$
$$= \frac{120{,}000}{0.0225 \times 9\, (1 - 0.4822) \times 248{,}832}$$
$$= 0.464$$

The face h of the flywheel required will be

$$h = pR = 0.464 \times 12 = 5.568 \text{ in.}$$

Problem 6. Find the energy of the web of the flywheel shown in Fig. 6, which revolves at 120 r.p.m.

First calculate the energy of the central cylindrical ring for which

$$p = \frac{0.5625}{18.08} = 0.0311$$

$$q = \frac{4.5}{18.08} = 0.249$$

$$E_c = 0.0209 \times 4 \times 0.0311\, (1 - 0.249^4) \times 18.08^5$$
$$= 5{,}001 \text{ in. lb.}$$

For the two frustums of a cone

$$p = \frac{0.4375}{18.08} = 0.0242$$

$$q = 0.249$$

$$E_f = 0.00418 \times 4 \times 0.0242 \times \left(\frac{1 - 0.249^6}{1 - 0.249} - 5 \times 0.249^4\right) \times 18.08^5 = 1{,}025 \text{ in. lb.}$$

Thus the total energy of the web

$$E_2 = E_c + E_f = 5{,}001 + 1{,}025$$
$$= 6{,}026 \text{ in. lb.}$$

It may be worthwhile noting that even in this case the energy of the web alone represents nearly 8½ percent of the energy of the rim.

The press shown in Fig. 7 has no flywheel, it is an example of the usefulness of the equations here developed in press design. In checking the moment of inertia of the revolving parts, it was discovered that a flywheel was not necessary. The result was that a 15 hp. motor was required to operate the press, instead of a 30 hp. motor which would have been required with a flywheel.

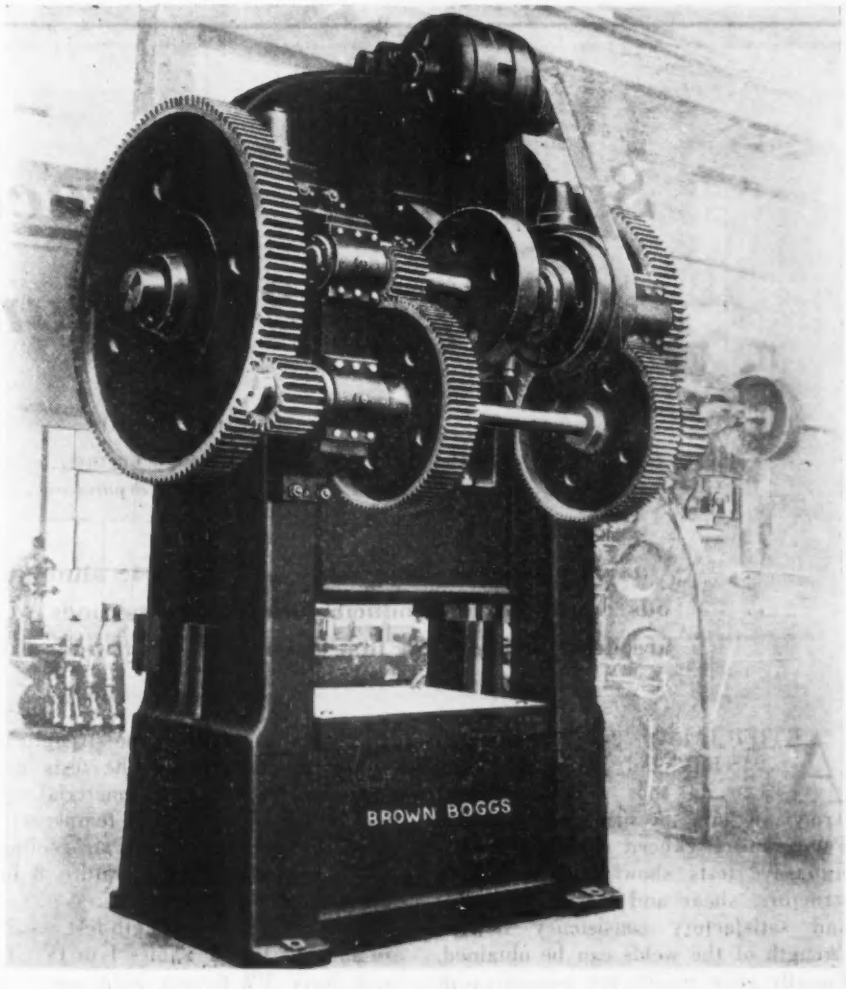


Fig. 7—No flywheel was required on this press. The energy stored in the revolving parts is sufficient for correct press performance.

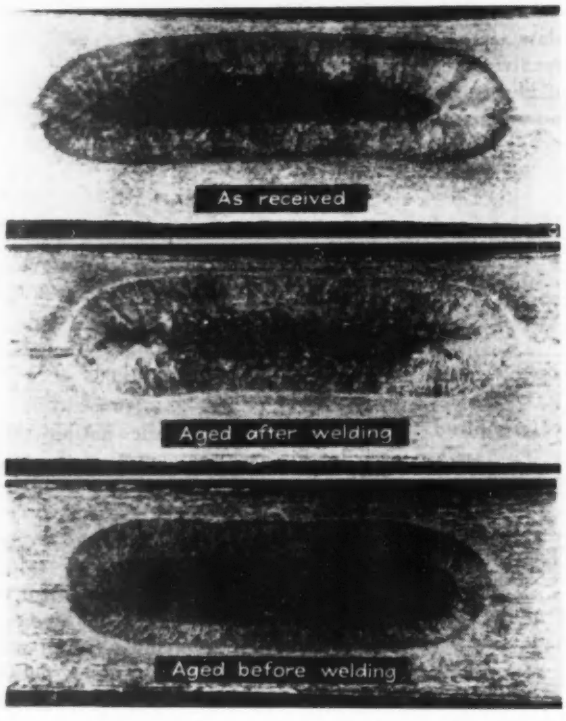


Fig. 1—Spot weld structure of 24S-T Alclad has no undue porosity or cracks and no penetration of the weld zone into the clad layer. Similar results were obtained on 24S-RT. 17X magnification.

Table I—Shear Test Results
25 Specimens —0.040 24S-T Alclad

Material Condition	Ultimate Strength			Deviation from Average, percent	Change in Strength, percent	No. of Specimens Within 10 percent Average
	Max.	Min.	Average			
As received (1)	585	490	534	+ 9.4 − 8.9		25
Aged to 24S–T81 after welding (1)	600	505	540	+11.1 6.5	+1.2	24
24S–T81 aged before welding (2)	520	415	472	+11 −11.4		23

(1) Welding conditions and machine settings identical.
(2) Machine settings varied from (1).

Table II—Shear Test Results
25 Specimens —0.040 24S-RT Alclad

Material Condition	Ultimate Strength			Deviation from Average, percent	Change in Strength, percent	No. of Specimens Within 10 percent Average
	Max.	Min.	Average			
As received (1)	540	470	508	+6 −7.5		25
Aged to 24S–T86 after welding (2)	515	460	487	+5.5 −5.5	−4.2	25
24S–T86 aged (2) before welding	540	470	510	+5.6 −7.8		25

(1) Welding conditions and machine settings identical.
(2) Machine settings varied from (1).

Spot Weld Characteristics Of Aged 24S Aluminum

M. L. OCHIEANO
Production Design Engineer
Lockheed Aircraft Corporation

Quality of spot welds in artificially aged 24S aluminum, conventional methods employed in producing them, and methods of investigating strength are described to show that satisfactory spot welds can readily be produced.

ARTIFICIALLY aged 24S-T and 24S-RT clad aluminum alloy can be spot welded to meet Army and Navy specifications 20011 and PW-6, and Lockheed standards easily. Extensive tests show that good weld structure, shear and tensile strengths, and satisfactory consistency in the strength of the welds can be obtained. Equally good results are possible with materials that are either artificially aged before or after welding, although aging does not increase the strength of the spotweld zone. In the tests discussed in this article, the material was aged by subjecting it to a temperature of 375 ± 5 deg. F. and air cooling. 24S-T was held at temperature 8 hr. and 24S-RT 6 hours.

Shear and tensile strength test results are summarized in Tables I to IV. To meet Navy PW-6 spot weld specifications, at least 21 of the 25 specimens must have shear and tensile strength within 10 percent of the average value. A variation of plus or minus 20 percent is permitted in the remainder. Army and Navy minimum shear values of 345 and 370 were exceeded considerably. Although the 24S-RT spot welds listed in Table IV varied more than 20 percent in tensile strength, the results were considered satisfactory because the failures were all above the upper consistency limit. Only the tensile strength was affected by the aging process. De-

Table III—Tension Test Results
25 Specimens —0.040 24S-T Alclad

Material Condition	Ultimate Strength			Deviation from Average, percent	Change in Strength, percent	Ratio of Tension to Shear Strength
	Max.	Min.	Average			
As received	185	150	177	+ 4.5 −15.2		33.1
Aged to 24S–T81 after welding	205	150	172	+19.2 −12.8	−2.8	31.8
24S–T81 aged before welding	215	165	184	+14.1 −10.3		39.0

Note: Welded in conjunction with corresponding shear specimens.

Table IV—Tension Test Results
25 Specimens —0.040 24S-RT Alclad

Material Condition	Ultimate Strength			Deviation from Average, percent	Change in Strength, percent	Ratio of Tension to Shear Strength
	Max.	Min.	Average			
As received	295	160	192	+53.7 −16.7		37.8
Aged to 24S–T86 after welding	235	155	180	+30.3 −13.9	−6.2	36.9
24S–T86 aged before welding	295	160	188	+56.9 −14.9		36.9

Note: Welded in conjunction with corresponding shear specimens.

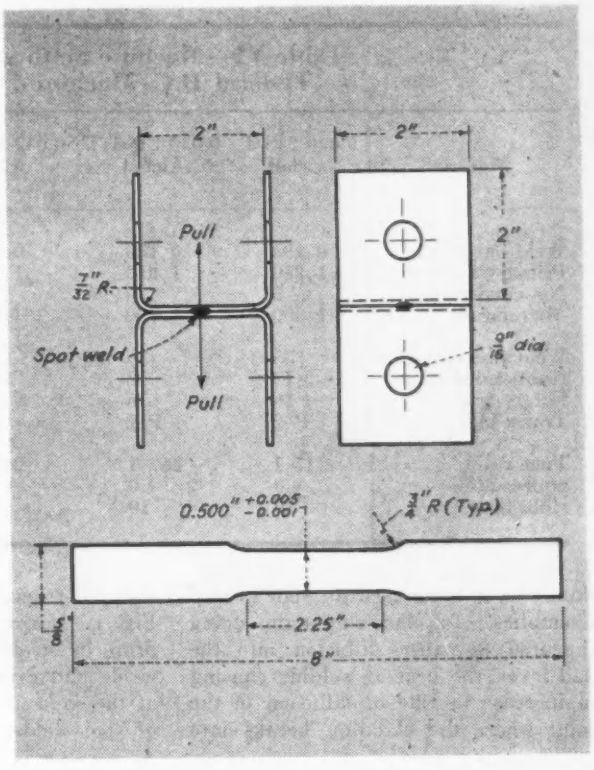


Fig. 2—Tensile tests were made on U-shaped specimens. Straight tensile control specimens were pulled to establish physical properties of the parent material.

creases in tensile strength of the welds after aging were caused by complete aging of the area immediately adjacent to the composite structure of the weld. The tensile test is also indicative of spot weld ductility inasmuch as the completely precipitated area around the weld has lower elongation, which results in reduced ductility. The measure of spot weld ductility is the ratio of tensile to shear strength.

Weld Ductility

Ductility of welds is well above Lockheed specification requirements, as indicated by the ratios of tension to shear strengths in the tables. A slight decrease in this ratio occurred in aged materials, indicating a slight embrittlement of the weld. However, the reduction was not sufficient to be of any consequence. Ratios of tensile to yield strength of all material combinations were more than the minimum requirement of 25 percent. A longer flow of weld current is recommended on the aged, or to be aged material, to improve weld ductility. This produces a larger heated area adjacent to the weld and a retarded rate of cooling of the weld bead.

Corrosion resistance is lowered by aging 24S material and should be investigated carefully when aged 24S

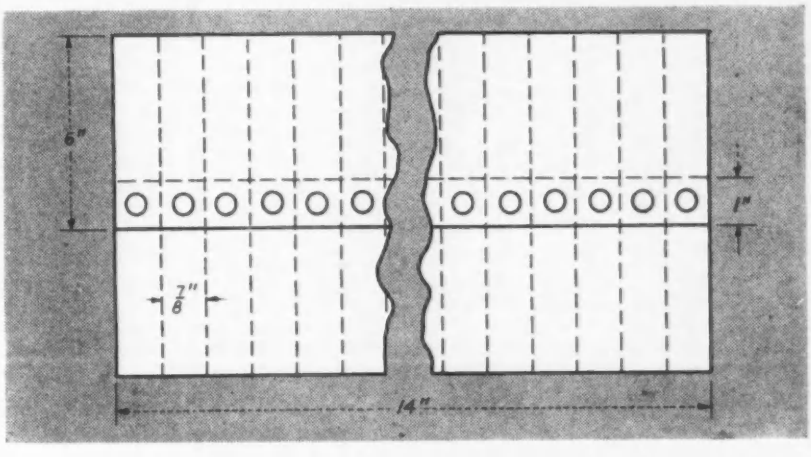


Fig. 3—Sixteen-spot shear test panels were sawed into ⅞ in. wide strips after spot welding and artificial aging were completed.

Table V—Characteristics of Parent Metal

Material Tested	Average Stress at Failure			Minimum Values Army Spec. 11,351		
	Ultimate Tension	Ultimate Yield	Elong. in 2 in. percent	Tensile	Yield	Elong.
0.040 24S–T Alclad	67,250	49,600	19	59,000	39,000	12
0.040 24S–RT Alclad	70,850	59,050	15.5	62,000	48,000	9
0.040 24S–T Aged to 24S–T81	68,850	61,850	7	62,000	54,000	5
0.040 24S–RT Aged to 24S–T86	72,500	66,500	6.5	66,000	62,000	3

Table V!—Machine Settings
Federal D.C. Machine

Material	0.040 24S-T Alclad	0.040 24S-RT Alclad	0.040 24S-T81 Alclad	0.040 24S-T86 Alclad
Weld button dia.	0.194	0.188	0.172	0.179
Primary voltage	1,850	1,810	1,810	1,810
No. condensers	5	5	5	5
Microfarads	1,000	1,000	1,000	1,000
Weld pressure gage	35	36	38	39
Rubber deflection	17	18	19.5	20
Forge—gage	16	16	16	16
Trans. tap	P–2	P–2	P–2	P–2
Turn ratio	247–1	247–1	247–1	247–1
Squeeze time	0	0	0	0
Hold time	10	10	10	10

aluminum is to be used for spot welded assemblies. In clad aluminum, aging appeared to cause diffusion into the clad layer, the heat of welding causing an increase in rate of diffusion to the point where the cladding breaks into distinct grains or blocks, as shown in Fig. 1. Corrosion caused a 4.5 percent drop in strength of spot welds. All welds had evidence of selective attack at the weld area. The faying surfaces of spot welds had no evidence of corrosion because sheet separation in this area was held close enough to prevent penetration of accelerated corrosion test solution (AN-QQ-H-186) to this surface. Corrosion test duration was 24 hours.

Standard shop methods of cleaning and etching aged 24S and 24S-T aluminum were found adequate preparation for spot welding if care is used in handling parts and timing immersion. The cleaner used was 6 oz. of Nobs No. 744 per gal. of water at 180 deg. F. applied for 7 min. followed by 15 sec. rinse in water at 180 deg. F. Oakite 84-A was used for etch at the same concentration and temperature for 5 min. followed by hot water rinse and hot air drier for 3 to 5 minutes.

Spot welds were made with a Federal d.c. welder having $\frac{5}{8}$ in. Mallory No. 3 electrodes with a top contact face diameter of $\frac{7}{8}$ in. with 2 in. radius of curvature, and a flat bottom contact face of $\frac{5}{8}$ in. diameter. Table VI gives machine settings for the four materials.

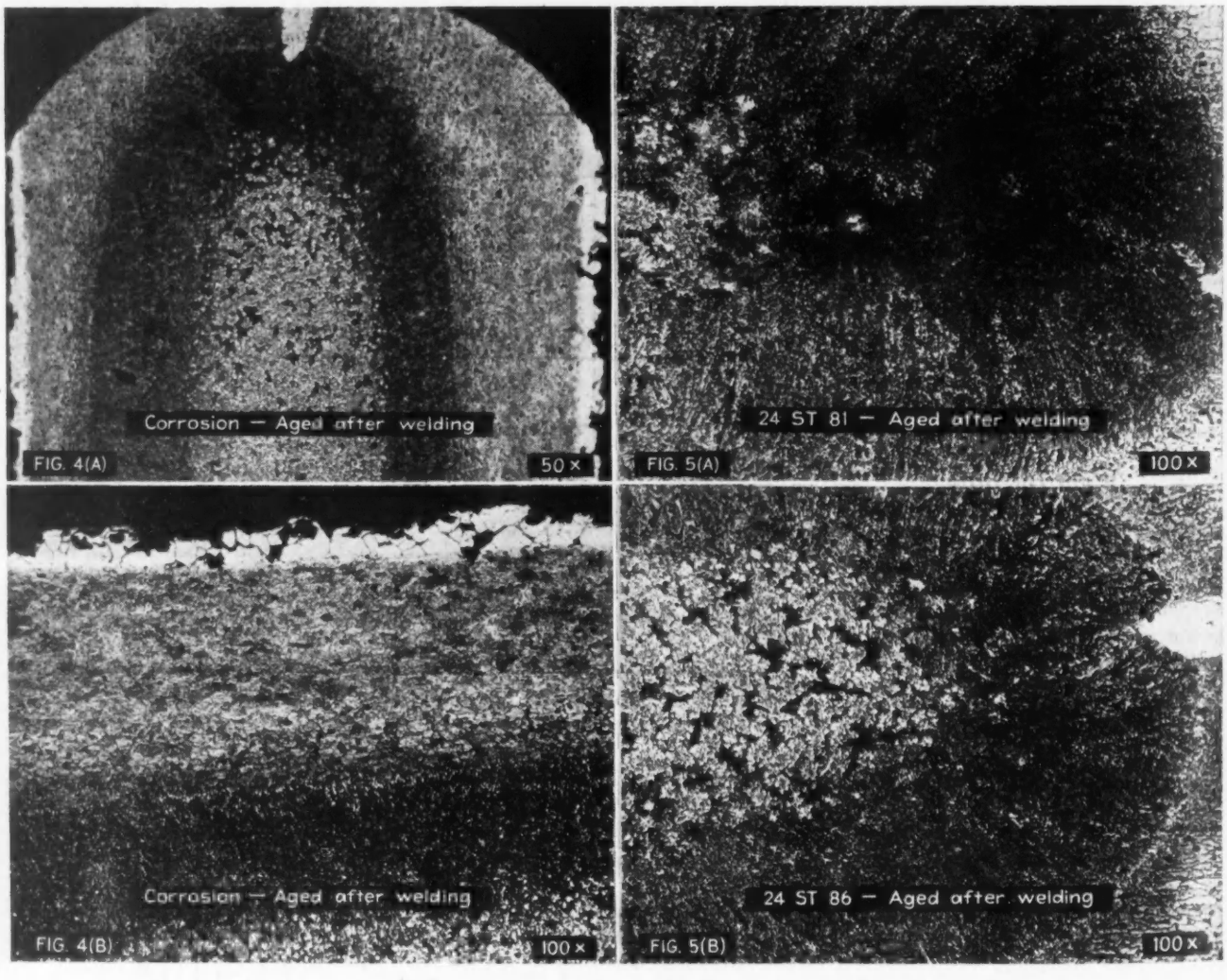
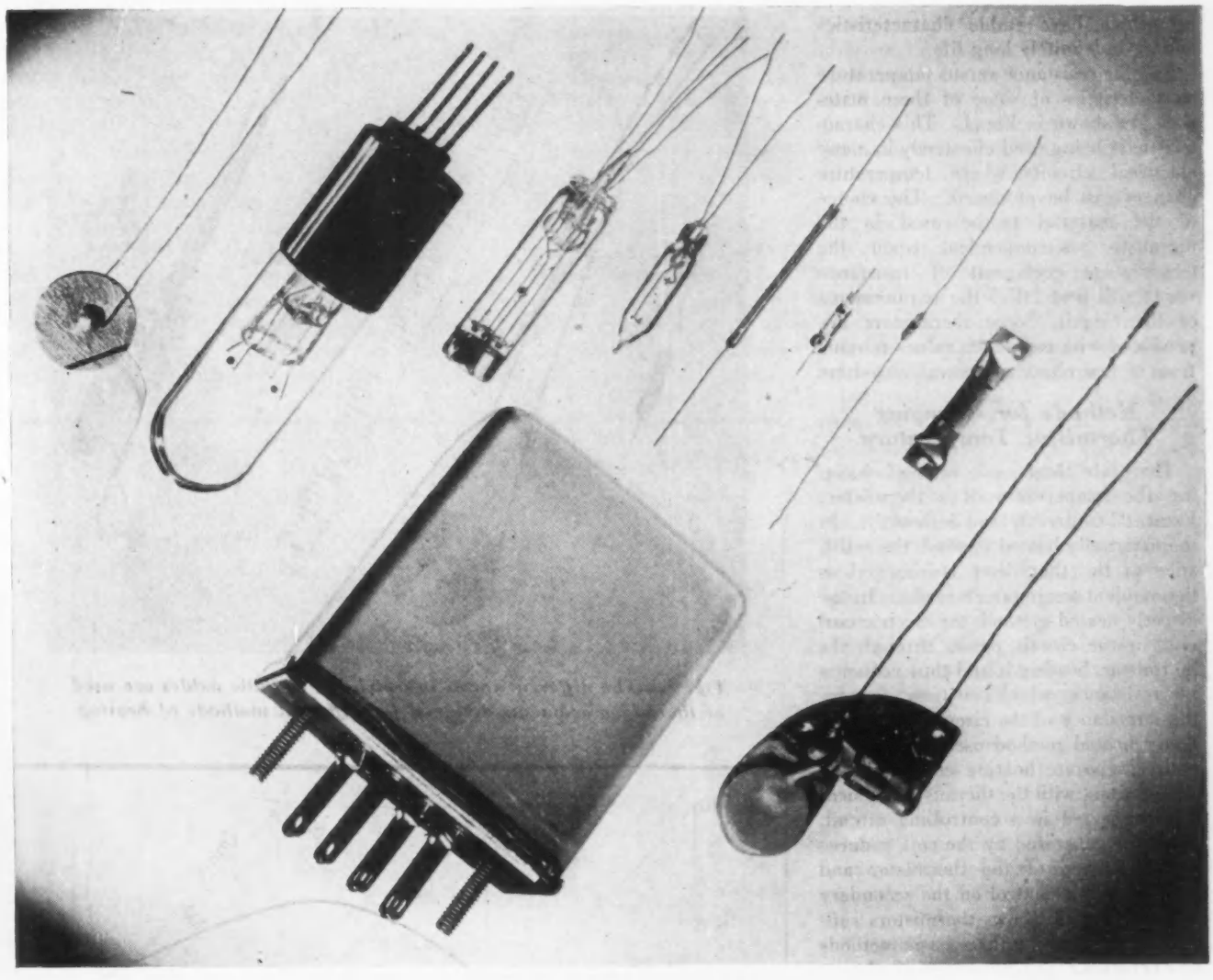


Fig. 4—(Left) In corrosion tests considerable breaking up of the clad surface into distinct grains or blocks occurred where the heat of welding affected the clad layer. Fig. 5—(Right) A completely aged precipitated condition is indicated in 24S-T material aged after welding.



Thermal Resistor Elements For Electrical Circuit Applications

ROBERT S. GOODYEAR
Western Electric Company

Characteristics and performance of thermal resistor elements, formed from metallic oxides, are described through the use of graphs. Details are given as to how these elements can be used in electrical circuits.

METALLIC oxides are members of a class of materials known as semi-conductors which are characterized by high negative temperature coefficients of electrical resistance. When pressed into disks, extruded rods, or formed into tiny beads these metallic oxides can be used as small electrical circuit elements which change electrical resistance with temperature. Some types change thier resistance five percent per deg. C. at room temperature.

The behavior of semi-conductors is not a new phenomenon, in fact Michael Faraday, as early as 1834, reported measurements on the extremely high negative temperature coefficient of resistance of silver sulphide. Electric heating elements of rare earth oxides were developed by Nernst fifty years ago. These early devices, however, were not easily reproduced and did not have constant characteristics or long life. In recent years, intensive study has been carried out at the Bell Telephone Laboratories, resulting in the present design of thermal resistors or thermist-

ors which have stable characteristics and an indefinitely long life.

Specific resistance versus temperature characteristics of some of these materials are shown in Fig. 1. This characteristic is being used effectively in many electrical circuits where temperature changes can be produced. The choice of the material to be used in the thermistor is dependent upon the temperature coefficient of resistance which will best fulfill the requirements of the circuit. Some thermistors are produced with resistance values ranging from a few ohms to several megohms.

Methods for Changing Thermistor Temperature

There are three basic ways of changing the temperature of a thermistor: Externally, directly and indirectly. In the externally heated method, the resistance of the thermistor is changed as the ambient temperature varies. In the directly heated method, the electric current in the circuit passes through the thermistor, heating it and thus reducing its resistance which in turn changes the impedance of the circuit. The indirectly heated method uses a thermistor with a separate heating coil placed in close contact with the thermistor element and connected in a controlling circuit. The heat generated by the coil, reduces the resistance of the thermistor and thus acts as a control on the secondary circuit. Fig. 2. shows thermistors suitable for each of the three basic methods of operation.

The static characteristic of a directly heated thermistor relating voltage, current, resistance and power is indicated

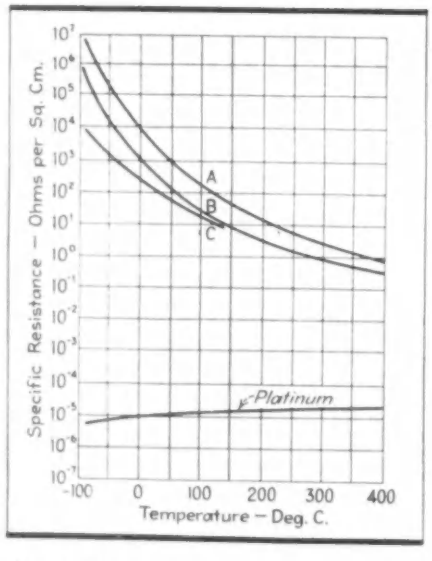


Fig. 1—Comparison of change in specific resistance with temperature of platinum and three metallic oxides A, B and C.

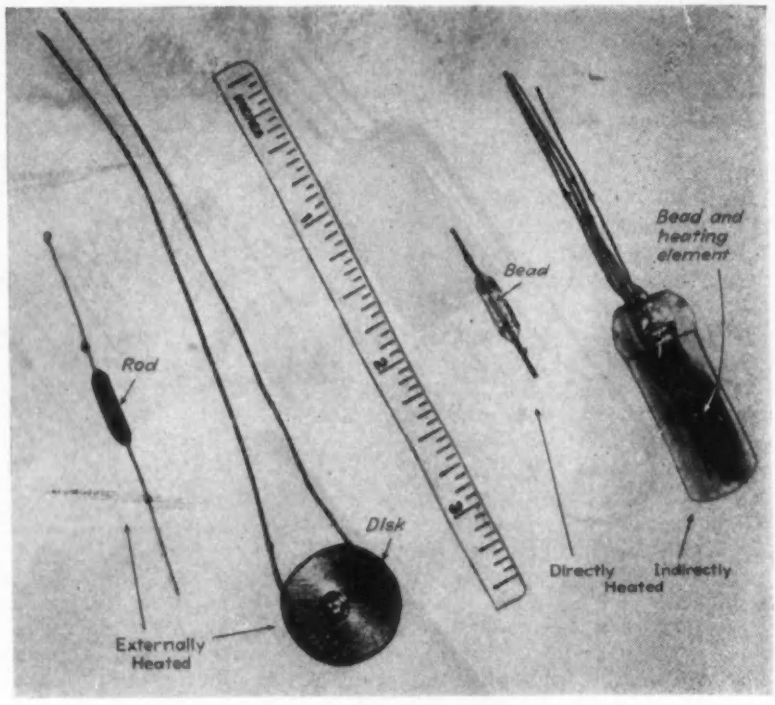


Fig. 2—The different forms in which the metallic oxides are used as thermistor elements designed for different methods of heating.

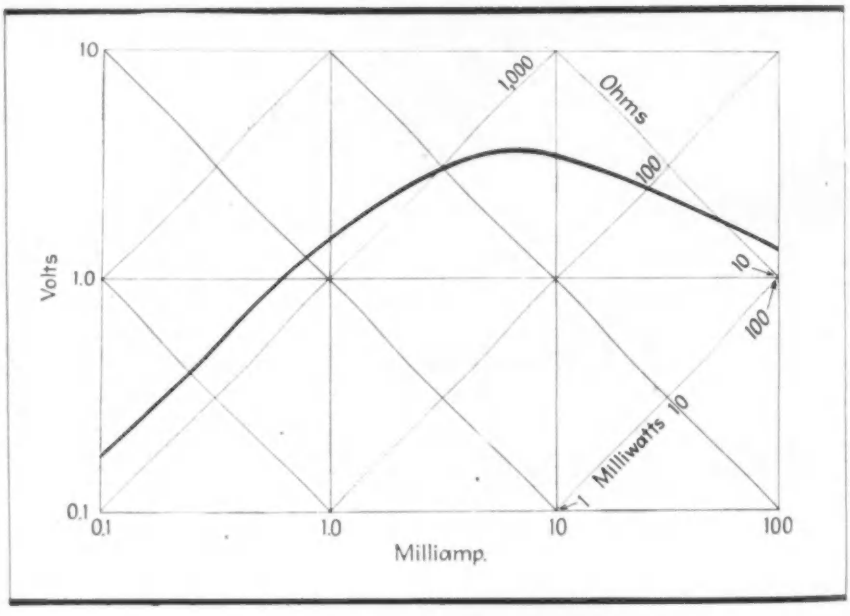


Fig. 3—Static characteristics of a directly heated thermistor relating voltage, current, resistance and power.

in Fig. 3. At low current the thermistor obeys Ohm's law and the plot is a straight line having a slope of 45 deg. As the current increases, and the bead heats up, its resistance and hence the slope of the curve decreases until the voltage reaches a maximum value at which point the slope is zero. As the current continues to increase the slope becomes negative and the voltage drops off rapidly. The falling portion of the curve therefore exhibits a negative resistance characteristic which finds uses in oscillators. Coordinates chosen are for one type of bead thermistor. The voltage and current range can be greatly extended by proper design of the thermistor.

The resistance of a directly heated thermistor versus power is shown in Fig. 4. This curve can be obtained also from the general characteristic in Fig. 3 by turning the curve 45 deg. clockwise in which case power is the abscissa and resistance the ordinate. This is a static curve since time was allowed for

the resistance to attain a steady value after each change in current. This characteristic finds use in power measurement of high-frequency electric circuits.

A directly heated thermistor can be used as a time delay device as shown in Fig. 5. The circuit consists of a source of voltage, key, milliammeter, and a resistance placed in series with the thermistor. When the key is closed, the meter will show a delayed building up of current caused by the thermal capacity of the thermistor. The delay is illustrated by the current versus time curve in which the initial current is limited by the high cold resistance of the thermistor and the final current by the rest of the circuit resistance. Time delays from a few milliseconds to as long as 30 min. can be obtained by a suitable design of thermistor and choice of circuit.

When placed in proper bridge circuits, thermistors find a wide variety of uses. Resistance thermometers, using a thermistor as the measuring element, give accuracy far greater than is obtainable with thermocouples, and have the additional advantage of giving absolute values without requiring any other reference such as a cold junction. Thermistors in similar bridge circuits can be used as flow meters or vacuum gages or wherever the physical quantities to be measured can affect the flow of thermal energy from a hot body.

Externally heated thermistors can be used as temperature compensators in any electrical circuit having a positive coefficient of resistance. Fig. 6 shows a typical circuit in which a thermistor is placed in series with a circuit to maintain constant resistance over a wide range of ambient temperature.

Indirectly heated thermistors can be used as variable resistance devices which are operated by an electric current through the heating coil rather than a sliding contact as in a standard rheostat. These devices have the advantage that their resistance change is continuously variable and that they may be operated electrically from a distant point.

Standard relays, subject to false operation caused by high voltage surges in the circuit, can be protected against such false operation by placing a directly heated thermistor in series with the winding. A short duration, high voltage surge will not have time to heat the thermistor sufficiently to pass the necessary current to operate the relay. A longer duration, lower voltage signal, however, will operate the relay as desired.

Thermistors have been enlisted by the Armed Forces for the duration, but when available, should provide engineers with a new device which will simplify and improve many of their postwar products.

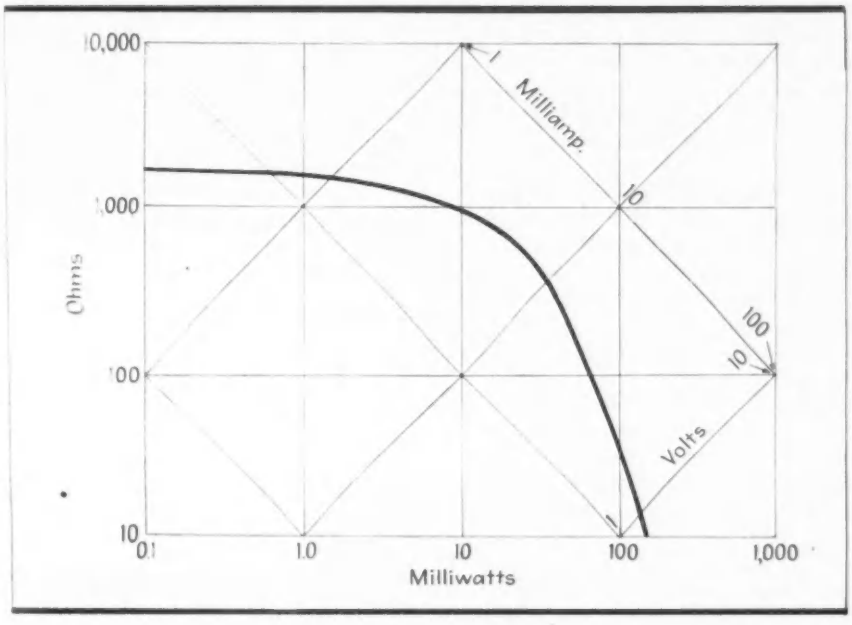


Fig. 4—Static curve of a directly heated thermistor where resistance is plotted versus power. The curve is obtained by allowing the resistance to attain a steady value after each change in current.

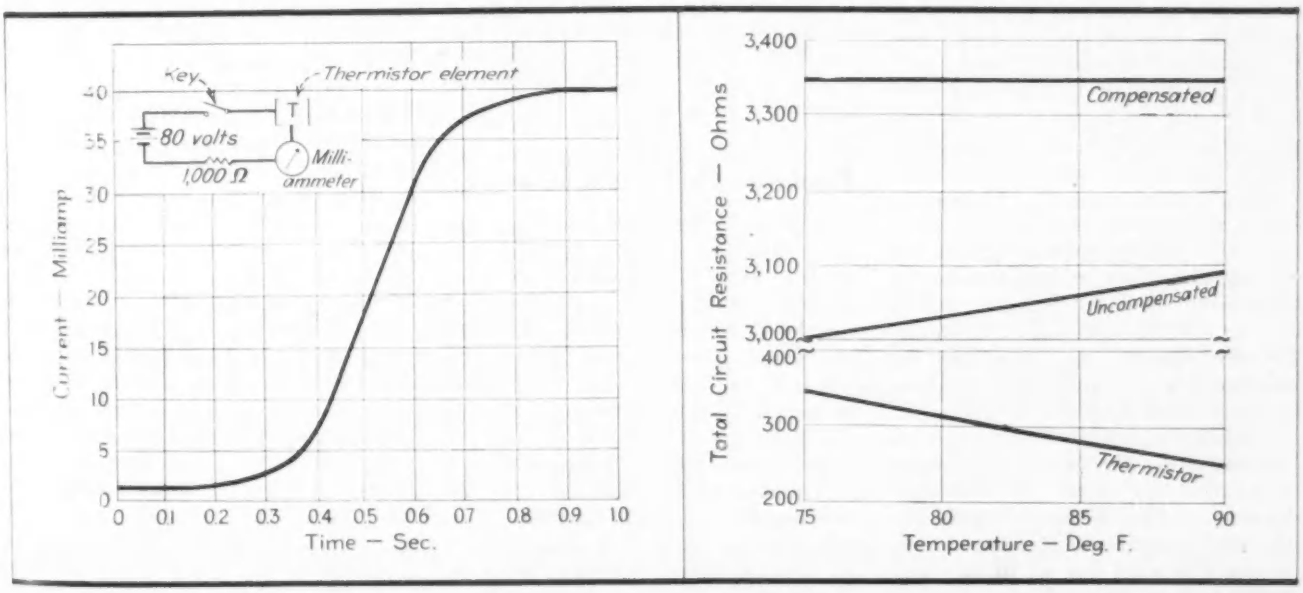


Fig. 5 (Left)—Directly heated thermistor element used as a time-delay device. Fig. 6 (Right)—Curves to indicate how the negative coefficient of resistance characteristic, of an externally heated thermistor, can be used to compensate a typical circuit and maintain constant circuit resistance over a wide ambient temperature range.

International Standards

WORK on U. S.-British standards for spark plugs, propellor shaft elements, hydraulic elements, electrical systems and fittings and plumbing attachments is to begin shortly as a direct result of the visit to the United Kingdom by a group of aircraft engineers representing the National Aircraft Standards Committee and the Society of Automotive Engineers. The group returned a visit to this country made last spring by British engineers. The U.S. group reported substantial progress toward greater uniformity of standard parts, materials and practices. Standardization in the British aircraft industry was reported greater than that yet practiced in this country.

New Compressed Wood

STAYPAK is the name of a new development in compressed wood revealed recently by the U. S. Forest Products Laboratory at Madison, Wis. A heat-stabilized, high-density product (specific gravity between 1.3 and 1.4), Staypak is made by compressing solid wood or numerous layers of thin veneers, and contains no resins other than those used in the laminated product to bond veneers during pressing. It was designed to have the same general characteristics as the Laboratory's earlier development, Compreg, a resin-treated compressed wood, but Staypak's toughness is about double that of Compreg. The development grew out of the embrittlement of Compreg resulting from the resins used.

Staypak was developed with an eye to eliminating the tendency of compressed wood cells to resume their original shape by inciting the flow of lignin during the compression. Temperatures necessary to start flow of lignin—high enough to burn the wood—were lowered by the use of plasticizers, of which water proved the most effective. It was finally shown that a compressed wood free of springback could be produced merely by compressing at higher temperatures and under greater moisture conditions than were originally used. Darker than ordinary compressed wood, Staypak assumes a smooth, satiny finish when compressed under polished platens. It machines easily with metal-working tools and takes a good polish on all cut surfaces.

At comparable moisture content and specific gravity values, Staypak's compressive strength, parallel and perpendicular to the grain, is somewhat below that of Compreg, but bending properties and tensile strength parallel to the grain is about 25 percent greater. Tensile and flexural values of parallel-laminated Staypak range from 40,000 to 45,000-lb. per sq. in., or double the average natural values for yellow birch and triple those of Sitka spruce. Compression temperatures at the middle of the material under the Staypak process limit the application, but panels up to 1.5 in. thick have been processed successfully. Cost is roughly proportional to the increase in specific gravity as compared to uncompressed wood. Manufacturing details may be obtained in report No. 1580 from the Laboratory.

Postwar Research Report

THE NAVY ACCEPTED and the War Department rejected the recommendations of the Army-Navy-Science committee headed by General Electric's President Charles E. Wilson for a means of assuring postwar continuation of scientific research and development aimed at keeping the United States in the swim as a military power.

The report, and the reports on the report made by high officers of each service, was turned over to the House Postwar Military Affairs Committee, headed by Rep. Woodrum, Virginia Democrat. Testimony taken by the committee should be published this month.

It was understood that the War Department is opposed to the idea of an independent agency to do postwar scientific research and development for the services, but there is no reason to believe that the Army is opposed to more than the form proposed by the Wilson committee, for Army men have been insisting for years that such work must be carried on in peacetime.

Foreign News

OPPORTUNITIES for American industry to obtain information on industrial developments, techniques, processes and materials developed in foreign lands to which there has been little or no access during the war probably will be limited for some time to come.

This material is hereafter to be gathered by specialists working under the newly-organized Technical Industrial Intelligence Committee, composed of the Army, Navy, WPB, Foreign Economic Administration and four other federal agencies. TIIC will operate through about 15 subcommittees for various fields of technology, the subcommittees assisted by outstanding men in each pertinent industry.

As enemy-occupied areas are liberated and as access to neutrals becomes more feasible, subcommittee agents who not only have an intimate knowledge of the field in which they work but who are armed with all available information on what to look for will scour these areas for new developments. While the committee was created to provide an organized means for obtaining such information, its findings will be channeled through Army Intelligence, the reluctance of which to divulge information is exceeded only by that of Naval Intelligence. Thus, the prospects of obtaining this information appear limited. One of the purposes of the organization is to discourage an influx of government people and representatives of private companies into areas which, when liberated, cannot accommodate such an influx.

The services are said to have fought

organization of TIIC for months, which is further indication of their attitude toward broad publication of material from liberated areas. That the committee was organized at all is regarded in some quarters as an indication that the Office of Strategic Services, which normally handles assignments similar to those of TIIC, may have fallen down on the job.

Captured Materiel

TREMENDOUS QUANTITIES of German equipment captured in the speedy drive through France are being used in the drive on Germany under an Army "Salvage and Utilization" program participated in by all branches of the ASF in the Communications Zone immediately behind the front.

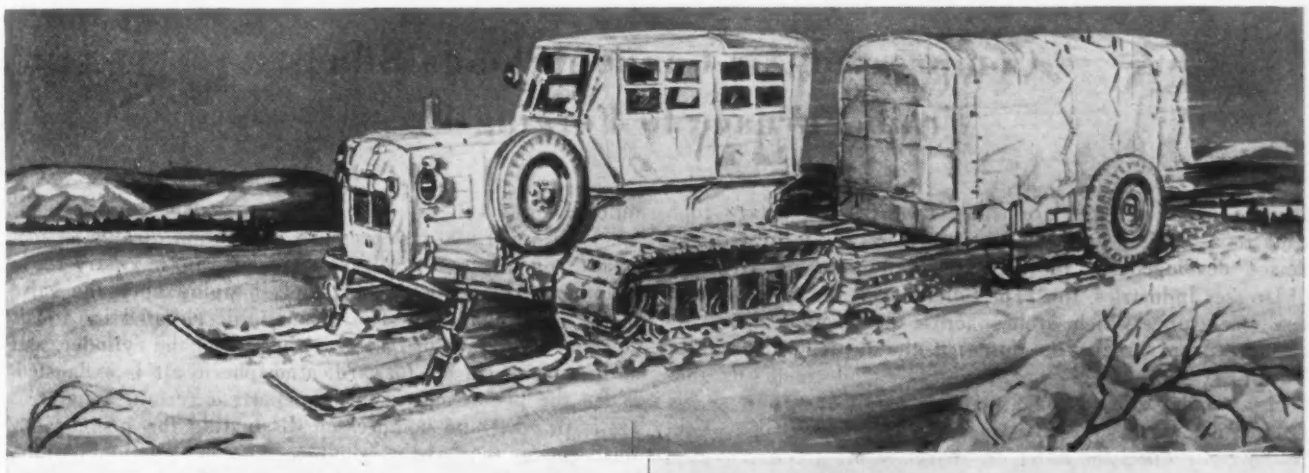
German vehicles are particularly valuable, but everything from small radio parts to huge field guns is used. German "spiral 4" telephone cables, for instance, are widely used in the Communications Zone while American supplies of this cable, considered somewhat more dependable even though the two products are very similar, are sent ahead to the battle areas.

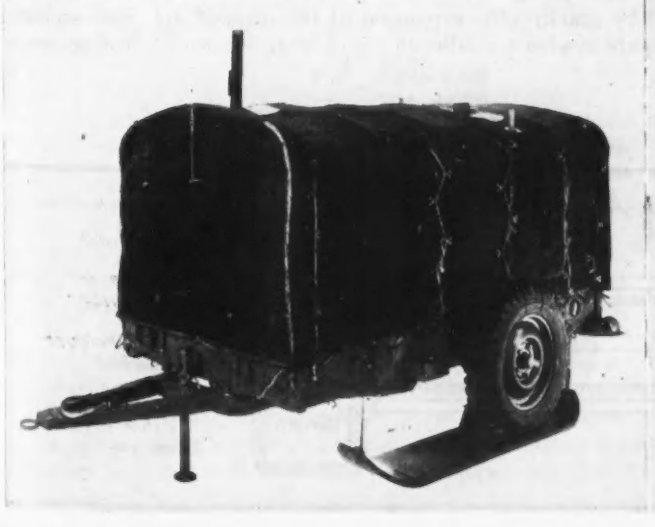
Captured stores were found in well-concealed caves, coal mines and tunnels which had been completely modernized even to installation of such equipment as air conditioning as well as electric lights and railways.

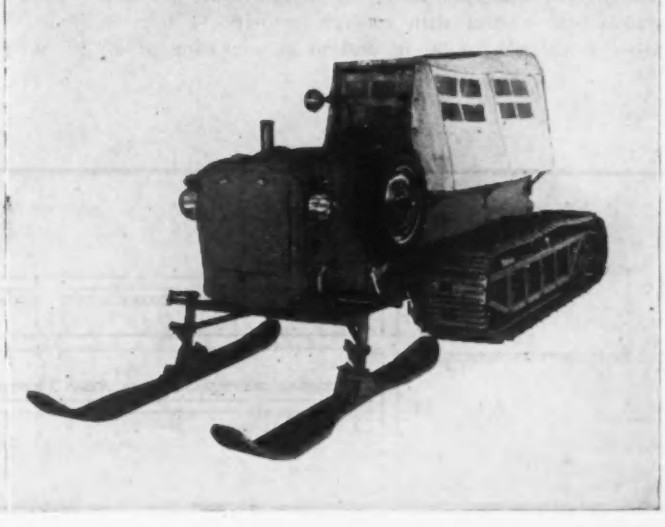
Army crews recondition damaged material and in some cases have revamped it for our use. Occasionally, special tools for converting the equipment had to be made. Cannibalization is common, but most of the captured materiel was found more or less undamaged in rear-area storehouses. Demolition attempts by the retreating Germans were generally ineffective, principally because they evacuated in a hurry.

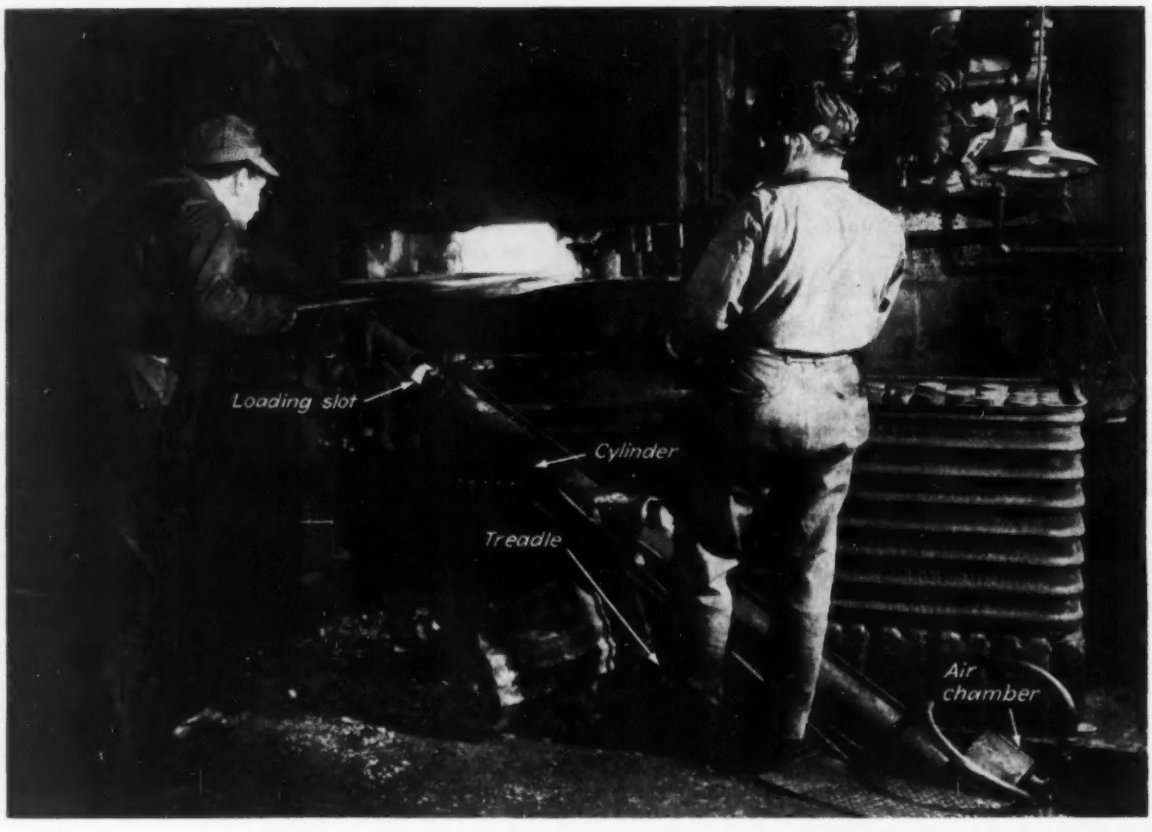
Versatile Snow Tractor and Trailer

A SPECIAL SNOW TRACTOR, model M-7, and a 1-ton snow trailer, model M-19, have been announced by the Allis-Chalmers Manufacturing Company and U. S. Army Ordnance and Army Air Corps. The two-man snow tractor has a front axle that can be equipped with wheels or skis and the long wide tracks with rubber faced shoes make it suitable for highway or snow travel. Powered by a four cylinder gasoline engine, developing 63 hp. at 3600 r.p.m., the tractor has six forward and two reverse speeds, ranging from 4 to 41 m.p.h. forward and 3 to 11 m.p.h. in reverse. Initially constructed as a rescue squad combination which could speed over snow covered topography to aid downed pilots and their crews, the snow tractor and trailer serve as a transportation means for hauling supplies in distant, frozen climates.





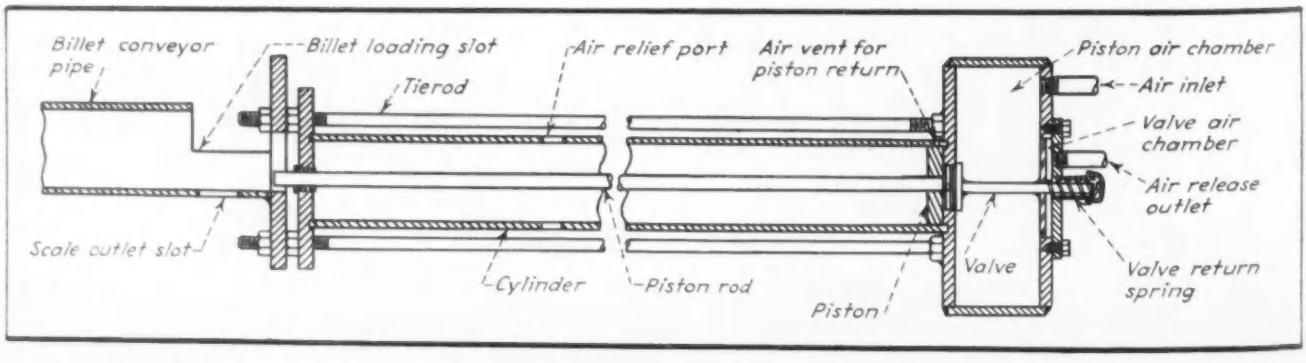




Compressed Air Cannon Shoots Billets From Furnace to Forging Press

HEATED STEEL BILLETS are transferred from a rotary furnace to a forging press 70 feet away by a compressed air device developed by the Dresser Manufacturing Division of Dresser Industries, Inc. The billet travels through a seamless steel tube, which arches across the factory floor. A circular drum breaks the force of the heated-billet's fall. The billet slides down the tube, hits a rod traversing the drum, tumbles around and drops into a hopper.

The "cannon" is a short-stroke piston and cylinder. The piston rod propels the billet. A charge of air accelerates the short-stroke piston with enough velocity to fire an 8 lb. billet a distance of 60 ft. and to an elevation of 30 ft. A quick-opening valve is used in an air chamber in which air is stored under 100 lbs. pressure. Operation of a small foot treadle opens an air release outlet in an auxiliary valve chamber, exhausting the air, and snapping open the valve to the main chamber. The piston is decelerated by an air cushion. Ports are drilled near the end of the cylinder, and as the piston travels forward, atmospheric air is exhausted. When the piston moves past the ports a certain amount of air is trapped and compressed dissipating the piston's forward travel. The piston is returned to the starting position by gravity plus expansion of the trapped air. Two seconds are needed for billet to travel from furnace to forging press.

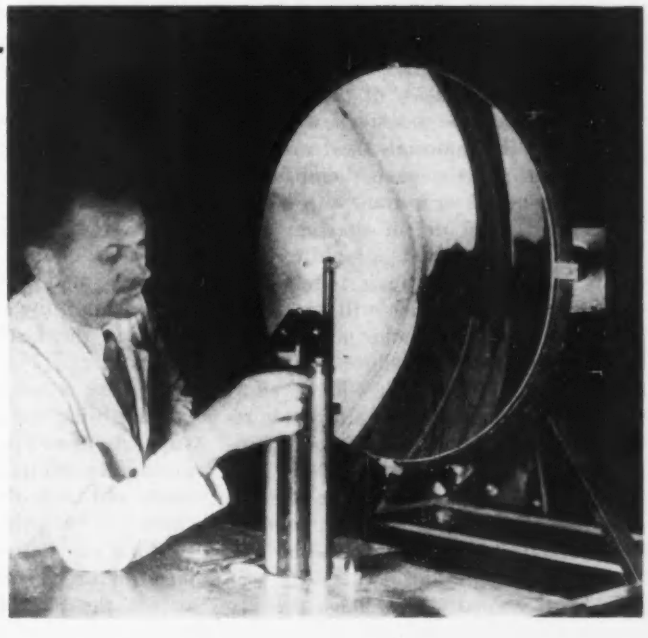


Helicopter Side Panels of Molded Laminated Plastic

FUSELAGE PANELS for the R-6 military helicopter are molded laminated plastic to obtain light weight; strength; insulating properties and resistance to oils, acids, alkalis, weathering and fungus. The panels are molded to exact shape during the original curing cycle, thus eliminating possible spring back and assuring an assembly that can be satisfactorily mass-produced. Panels are produced by Haskelite Manufacturing Corporation.

Hard Alloy Used for Navy Searchlight Reflectors

TWENTY-FOUR INCH searchlight reflectors built by the Chrysler Corporation for the United States Navy are made of non-magnetic cobalt-chromium-tungsten alloy. An electronically controlled machine produces the 24-in. parabolic shape. The surface is then superfinished. The reflectors withstand corrosion or tarnishing from salt air or spray, gaseous fumes, damage from hot particles which might sputter from electrodes producing the light, scratching or wear caused by polishing, oxidation caused by heat from electrodes, and the shock of concussion from gunfire. Surface finish is so accurate that reflected beams of light will not deviate more than 8/1000ths of an inch in two miles. When a 2,000 candlepower arc is placed at the focal point, a 30,000,000 candlepower arc is placed at the focal point, it develops a 30,000,000 candlepower beam that shines more than 20 miles.



Design of Hydraulic Systems
II—Packings and Their Application

HOWARD FIELD, JR.
Consultant

The problem of selecting a fluid seal or packing is discussed as to materials, types available, purpose of the seal, installation problems and advantages and disadvantages of each type of packing.

IN EVERY hydraulic system, seals are used to prevent leakage through the clearance spaces between stationary members and moving members such as piston rods, shafts and pistons. The ideal packing would seal without any leakage whatsoever, wear indefinitely, not cause wear on the moving parts, have no frictional drag, be unaffected by temperature changes and be entirely inert chemically with respect to the surrounding parts and the fluid. This is an ideal which will never be attained and, at present, is not even approached. The seriousness of the problem has spurred research and development for many years, as a result of which, many types of packings have been developed.

Compression Packings

The earliest packings were of the compression type, the design of which, for a great many years, remained unchanged, except for material. The compression packing consists of a housing or packing, box to confine the packing material, a gland to compress the packing, and the packing itself. The packing material is selected to suit the fluid, the speed of movement, the allowable leakage, the life, and the personal idiosyncrasies of the man installing it and the salesman who sold it. Among the materials used are: Asbestos, yarn, cotton yarn, hemp, cork, leather, asbestos or cotton with a rubber binder, lead or tin shavings with asbestos, cotton and graphite, and many others. The aim is to obtain a resilient material which will so closely follow the surface of the moving part that there will be no clearance through which the fluid can leak. Much effort has been expended to obtain better results by making rings of various cross-sections.

Compression packings have the advantages that they are simple, familiar to mechanics, readily replaceable, seal in both directions, and if they leak they can be tightened. They have the disadvantage that their frictional drag usually is great since they must be sufficiently tightened to seal at the highest pressures, making them unnecessarily tight for low pressures, and mechanics often overtighten them.

U-Cup Packings

In the effort to make packings adjust themselves to the applied pressure, several "automatic" types have been developed. The earliest of these is known as the U-cup. The U-cup is made from a highly resilient material and, in the free position, has several degrees flare so that when installed it hugs tightly against the surrounding surfaces. Spring expanders are used frequently to hold the packing lips outward more positively. A retainer is used to prevent the drag on the moving member from turning the cup inside out and holes must be made through the retainer so that the hydraulic pressure on the inner and outer lips will be equal. The U-cup packing seals well, particularly at low pressures, and is good at high pressures if the clearances between the supporting structure and the moving member is made small, a maximum of 0.003 in. diametral clearance. Its disadvantages are principally caused by the large surface in contact with the moving member which causes high frictional drag and the fact that it is made of highly resilient material which usually has short wearing life and poor anti-extrusion qualities.

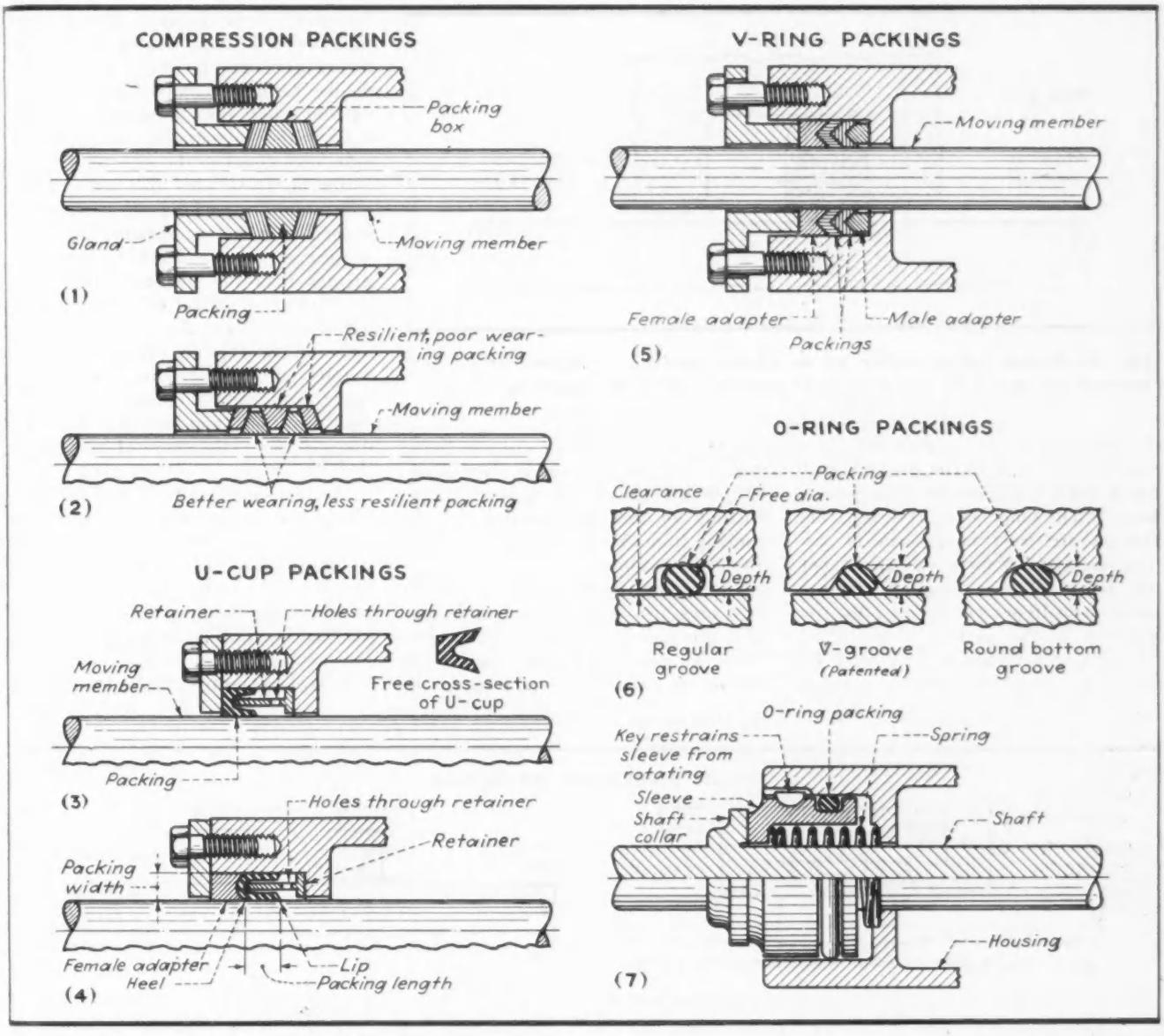
When made of leather the U-cup packing is quite satisfactory if care is taken in the installation. The critical points are: (1) The female adapter must have a correctly shaped face in contact with the packing to properly support it; (2) the female adapter must have minimum clearance on both outer and inner diameters in order that there will be little space into which the packing can extrude; (3) the supporting structure should have no sharp edges to cut the packing; (4) the packing length should not exceed the width for two reasons—first, deeper packings are difficult to make and not as uniform as square ones; second, deeper packings have too much area in contact with the moving part, thereby causing execessive friction.

All the sealing by a U-cup packing is done at the lip and none at the heel, even though the whole length is held in contact, with the moving member, by the hydraulic pressure. If the length is made too short, the packing may have too little flexibility. The proper proportions of length to width lie between 0.6 and 1.0. This is emphasized because leather has often been condemned as a packing when the only trouble was that the designer insisted upon using incorrect proportions.

U-cup packings seal only in one direction. If for safety reasons more than one is used, they should be arranged in separate supporting structures so that the load on one does not tend to compress the other.

V-Ring Packings

The second type of automatic packing has become known as the V-ring. These packings are made from leather, synthetic rubber, rubber asbestos combinations and many other materials. A V-ring packing installation consists of one or more packings supported by male and female adapters. Although these adapters are frequently made from a rubber-bonded fabric-base material, experience has shown the advantage of using metal for the female and metal or plastic for the male. The dimensions of the adapters depend upon the size of the packing but the male adapter should always provide inside and outside clearance for the lip of the packing. The female adapter should fit inside and outside as well as possible, say 0.003-0.005 in. diametral clearance for small sizes and a little more for larger sizes. The included angle in the V-rings is 90 deg. so the adapters should be made with included angles of about



(1) Earliest type compression packing. (2) Compression packing using a combination of rings, made from resilient but poor wearing material, to hold better wearing but less resilient rings in contact with the shaft.

(3) U-cup packing has a flared cross-section and requires a retainer to keep the moving member from turning the packing inside out. Holes in the retainer balance the hydraulic pressure on both lips of the packing. (4) U-cup packings seal at the lip, although the whole length of packing, from lip to the heel, contacts the shaft. Packing length is critical and should range from 0.6 to 1.0 of the packing width.

(5) V-ring packings usually have two or more packing rings supported by male and female adapters which are most satisfactory when made of metal but are frequently made of a rubber-bonded fabric-base.

(6) O-ring packings may use any of three groove forms, but the groove depth should be 10 percent less than the free diameter of the packing. (7) A seal for high rotational speeds and moderate pressure depends upon the fit between the shaft collar and sleeve. The sleeve being held against the collar by spring load and hydraulic pressure. Seal between sleeve and housing is maintained by an O-ring packing.

95 deg. so that the packing can expand against the proper surfaces.

The V-ring packings should never be compressed, but only tightened finger-tight. When overtightened, they become a simple compression packing and all self-adjustment is lost. When undertightened they may leak at low pressure. When this style of packing leaks under ordinary circumstances, it is usually because of too hard material, wrong size, rough surfaces on the surrounding parts, or damaged packings. V-ring packings have less friction than U-cup packings, but like U-cup packings, seal in one direction only. Their disadvantages are the costly structure required to support them, the difficulty of preventing all leakage at low pressure, the habit of mechanics to overtighten them, and the designer's assumption that they are foolproof. Any packing must be properly used and supported if satisfactory performance is to result and U-rings are no exception.

O-Ring Packings

One of the most modern packings is the O-ring. These packings must be made from highly resilient material or

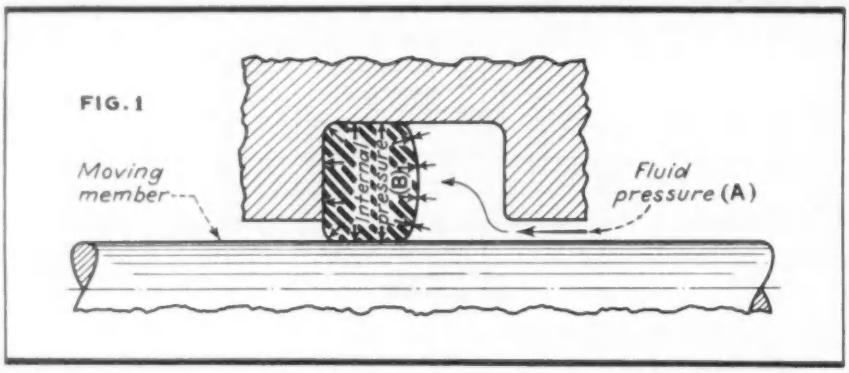


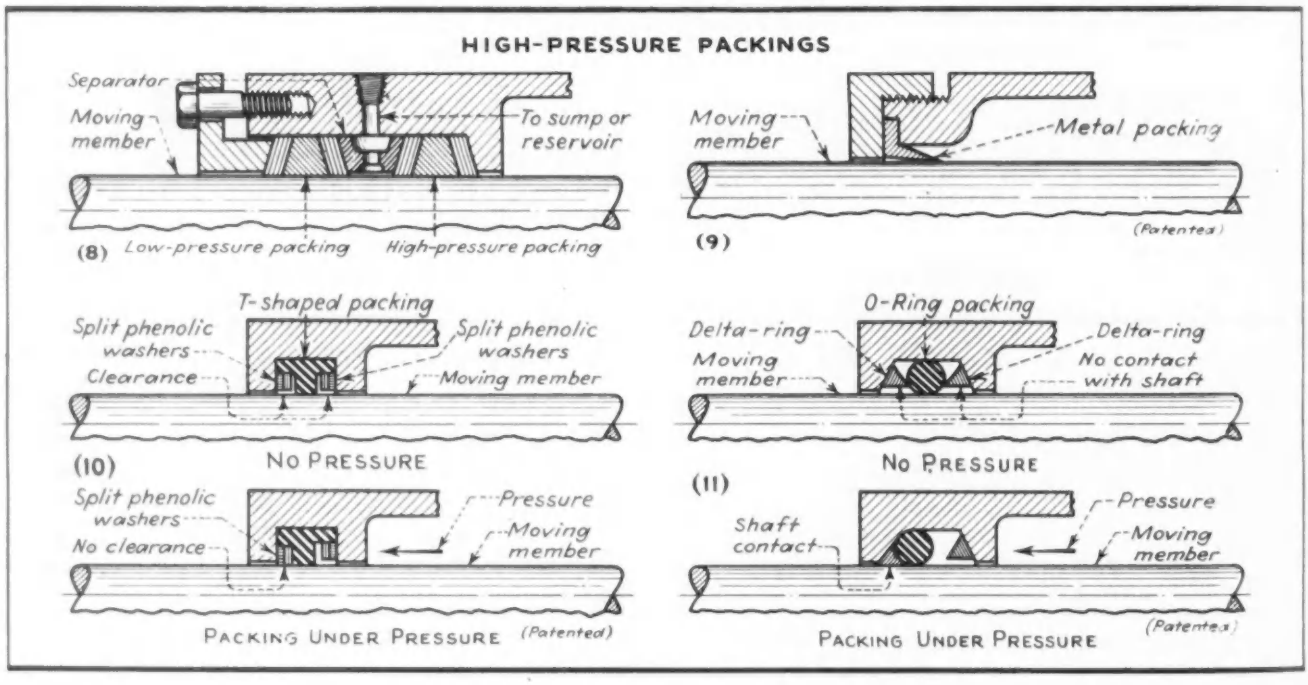
Fig. 1—High-pressure sealing of an O-ring packing is dependent on the internal pressure (B) set-up by fluid pressure (A) acting upon it.

they will not seal at low pressures, since it is the resilience of the packing itself which holds it against the adjacent surfaces when under low pressures. The O-rings are used in grooves of rectangular form, V-form and round bottom, but in all cases the groove depth is made about 10 percent less than the free diameter of the packing cross-section. The clearance should be kept small because the resilient materials tend to extrude readily. The cross-sectional area of the groove is made about 25 to 30 percent greater than that of the packing so that any swelling of the packing from the chemical action of the fluid, will not bind the parts.

The reason the O-ring packing seals high pressures is shown in Fig. 1. The fluid pressure is assumed to be applied from the right in the direction of the arrows *A*, moving the packing to the left end of the groove. The applied pressure *A* is then reacted by the internal pressures *B* which act perpendicular to the boundary surfaces of the packing and thus hold the packing against the surrounding parts with a unit force equal to the sum of the unit hydraulic force plus the initial force with which the packing was compressed between the moving member and supporting structure. Since this sum is greater than the hydraulic force, the hydraulic fluid cannot move the packing out of contact and thus permit leakage.

O-ring packings are extremely simple, require no adjustments, take little space, are readily replaceable, seal in both directions, and have low frictional drag. However, the material from which they are made is not as abrasion resistant as some less resilient materials. The action of the packing is such that abrasive matter tends to embed in the packing and rapidly wear the surfaces over which it rubs. Unlike the other packings, heretofore discussed, they do not function well as rotary seals except for slow speeds.

A sealing means which has proved



(8) The earliest type of high-pressure packing consists of two sets of packings and a separator. Leakage occurs through the high-pressure packings and is returned to the sump at the separator. The other packing, under low pressure, has no difficulty preventing leakage.

(9) A metal packing, similar to a U-cup in action, is good at high pressures but leaks at low pressures.

(10) A new type of high-pressure packing consists of two split phenolic washers on either side of a T-shaped synthetic rubber packing. Without pressure there is clearance between the phenolic washers and the shaft, but as pressure is applied from the right, the T-shaped packing is forced against the left phenolic washers causing the right arm of the packing to thin out. This material flows into the left arm forcing the phenolic washers in contact with the shaft and preventing extrusion of the packing.

(11) Two Delta-rings and an O-ring packing make up this high-pressure seal. As pressure is applied from the right, the O-ring packing moves against the Delta-ring forcing it in contact with the shaft and preventing extrusion of the O-ring packing.

satisfactory for high rotational speeds and moderate pressures consists of a collar carried by the rotating shaft against which a sleeve, restrained from rotation by a key, is held by a light spring. A packing prevents leakage between the sleeve and the supporting structure. As pressure in the housing increases, the sleeve is forced tighter against the collar thus preventing leakage. It is obvious that the collar must be hard and the sleeve must be made of a material which will run well with it. It is necessary that the faying faces of the shaft collar and sleeve be square, almost optically flat, and have a finish of 2 RMS microinch. This type of seal is not adaptable to parts having straight line motion, such as piston rods nor where two-way sealing is required. It is expensive, but if made from proper materials has a long trouble-free life.

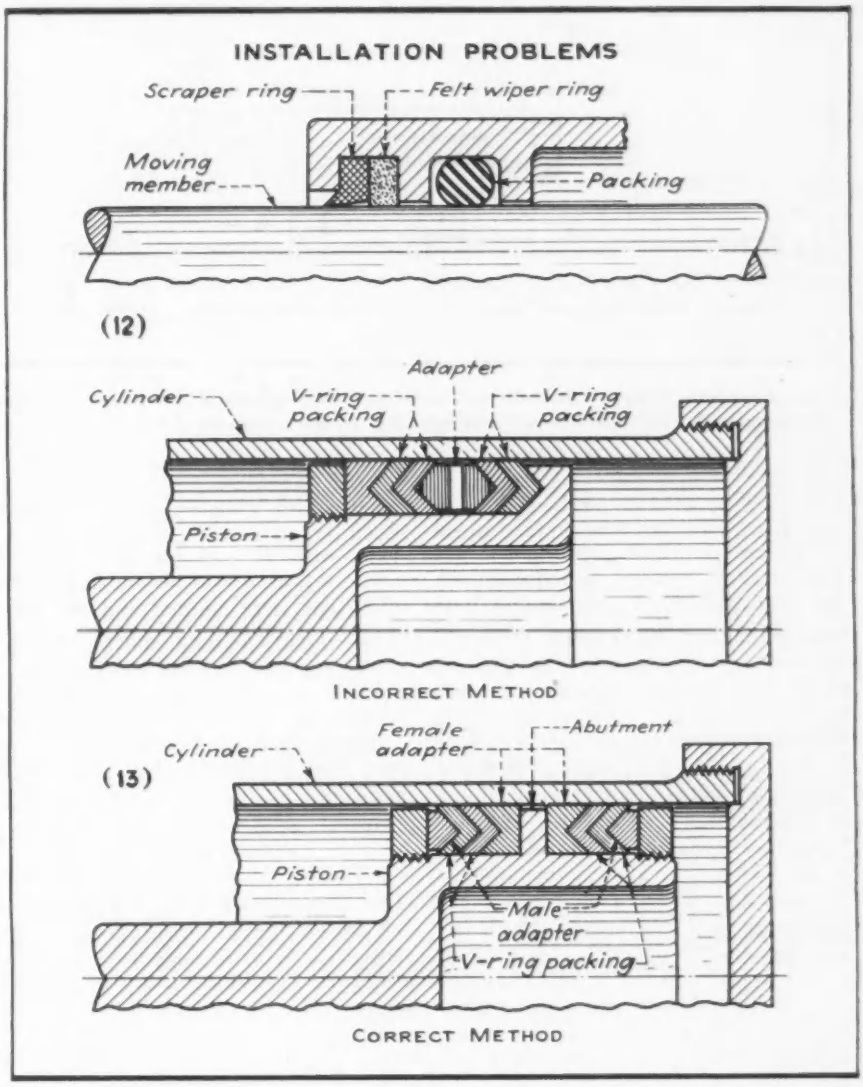
High-Pressure Packings

A number of schemes have been used to make packings satisfactory at high pressures. One of the earliest, constructions still in use, consists of two sets of packings and a separator. It is expected that the internal set of packings, being subjected to high pressure, will leak a small amount. This leakage can be collected in the separator and piped away, leaving the other set of packings under low pressure which they hold with practically no external leakage. In some variants of this scheme, pressures are maintained in the separator.

Another high-pressure seal is similar in action to the U-cup but is made from metal, usually stainless steel, bronze or silver. These packings require extremely good workmanship on the moving part as well as on the packing itself and even when made with great care, usually leak at low pressures.

A new high-pressure packing with a synthetic rubber T-shaped packing, backed on either side by two thin split phenolic washers, is patented by Jackman. With no pressure applied there is clearance between the phenolic washers and the moving member. As pressure is applied the stem of the T-shaped packing is forced against one pair of the phenolic washers and one arm of the T-shaped seal becomes thinner. The material must go somewhere, and thus thickens the other arm of the T, which forces one pair of the phenolic washers into contact with the moving member, eliminating any clearance into which the T-shaped packing might extrude. If extrusion is eliminated, the packing can seal any reasonable pressure.

A different means of preventing extrusion is the patented Delta-ring. Used with any of the standard automatic packings, Delta-rings are not in contact with the moving member when no pressure is applied. As pressure is applied the packing contacts the Delta-ring forcing it, because of its wedge shape, into contact with the moving member. The Delta-rings can be made from any flexible material which does not readily extrude. Obviously, the material chosen should run with the moving member.



(12) Where dirt is a problem, the combination of a scraper ring, to remove large particles, and a felt wiper ring, to remove small particles, protects the packing from excessive wear.

(13) The use of V-ring packings to accomplish a two-way seal, in a piston is often incorrectly designed. The V-ring packings should never be arranged face to face as this method allows the fluid to be trapped causing high fluid pressure between the packings, and piston seizure when the piston expands. The correct method places the packings back to back thus preventing trapping of fluid between them. An abutment, machined on the piston, insures that each packing will carry its own load and not transmit it to the other set of packings, as in the case where the abutment is omitted.

Installation Problems

The installation of all packings is important if satisfactory service is to result. One important factor is the elimination of abrasive foreign matter. Suppose that a piston rod extends into a dusty place. As it reciprocates, it carries dust into the packings, thus wearing both the packing and the rod. One way of minimizing this is to use a scraper ring that hugs the rod tightly and scrapes off large particles of dirt. In combination with the scraper ring a felt wiper ring can be used to remove fine matter. This scheme helps tremendously in removing the dirt. Sometimes a V-ring, or special synthetic scraper is used in place of the

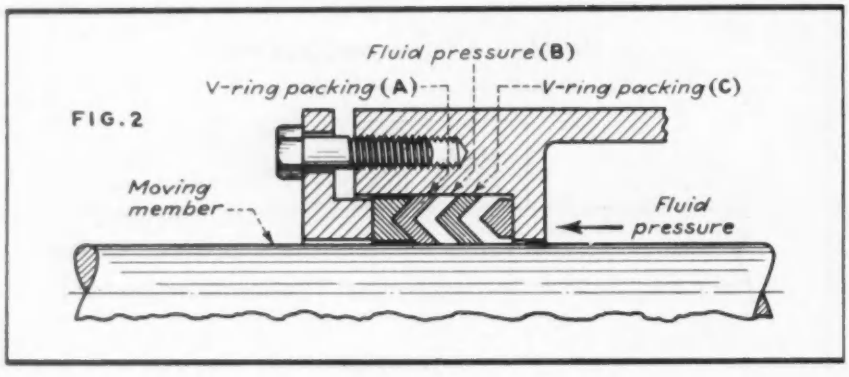


Fig. 2—Exaggerated example to indicate why multiple packings do not equally divide the function of sealing, and create excessive friction.

scraper ring. Considerable test work has shown that it is frequently worse to use the felt wiper alone than to use nothing at all, because the felt may pick up large abrasive particles and hold them in contact with the rod. It should be realized that a felt ring can be used alone, in clean places, and may prolong the packing life by providing needed lubrication. The Delta-ring is in itself a fairly efficient means for preventing abrasives from embedding in the packing.

Another installation problem which is often badly bungled is the problem of using two one-way packings to make a two-way seal. A method, which has even been recommended, uses two V-ring packings to accomplish a two-way seal, as required in a piston packing. Two sets of V-rings are set face to face with an adapter ring between them. If pressure is applied to one side of the packing, fluid will flow past one set of packings and be held by the other set of packings, thus filling the space between them. If this were done at low temperature and the temperature later increased, as is usually the case, the fluid trapped between the two sets of packings would tend to expand, thus tremendously increasing the pressure and either destroying some part or binding the piston badly. In some instances, it has been necessary to use an arbor press to move the piston. In a relatively thin cylinder, such as used in aircraft work, the cylinder expands when under pressure. This makes more space between the sets of packing which is promptly filled by fluid. When the piston approaches the end of the cylinder, there is less expansion because the end caps support the cylinder wall consequently the space grows smaller, increasing the pressure of the trapped fluid.

The proper way to solve the problem of a two-way packing, with no trapped fluid to cause trouble, is to use packings back to back and two female adapters supported by an abutment, which is machined on the piston. Each set of packing supports its own load without transmitting it to the other set, as would be the case if the abutment were omitted and the adapters supported each other. If two-way packings, such as compression or O-rings are used, no more than one should ever be applied unless the space between them is vented in some manner. To use more than one set of packings is asking for trouble from trapped fluid, since eventually the space between them will fill with fluid.

In times past, it was general practice to stack up V-rings somewhat in proportion to the pressure to be sealed. Often six or more were used. Modern designers who have given thought to the matter seldom use more than two or three. The author feels that more than one is a waste of material and causes unnecessary friction although sufficient tests to prove this point have not been performed. Excessive leakage will give warning that breakdown has started long before the complete failure of V-ring packings in proper supporting structures.

The problem, created by multiple packings, is shown in Fig. 2 in an exaggerated manner, where two V-rings *A* and *C* are assembled in the normal manner. At first *C* is supported by *A*, when pressure in the direction of the arrow is applied, but gradually the fluid leaks past *C* and is held by *A* thus filling the space *B* between the V-rings. From this point any pressure applied to *C* is transmitted in full by the fluid *B* to ring *A* which is the only effective seal. Ring *C* causes some friction and wears out slowly but ring *A* wears much more severely as has been shown by examination of many packings. In other words, the rings do not divide the work, but ring *A* does the whole job. Before fluid has leaked past ring *C*, the pressure holds it against the moving part causing frictional loss. Ring *C* wedges ring *A* against the moving part causing additional friction. Thus, two V-rings without fluid between them cause approximately twice the friction of one V-ring. The same reasoning applies to one-way packings when used in tandem.

No mention has been made of metal piston rings, similar to internal-combustion engine piston rings. Although they continually leak and do not approach a perfect seal there are many applications where they are the most satisfactory answer. In fact, they should be seriously considered wherever a slight leakage is not detrimental. The same should be said for labyrinth packings for rotating members but the difficulty of sufficiently accurate production and maintenance of clearances must be considered.

One important consideration when designing any unit containing packings of any type is the provision of adequate bearing surfaces. Not only are packings not adapted to carrying bearing loads, but inadequate bearings frequently permit so much play that the sealing problem becomes insurmountable.

Many of the packings, described in this article, are patented and arrangements for their use should be made with the patent owners or their licensees who, ordinarily, are satisfied with supplying the packing itself.

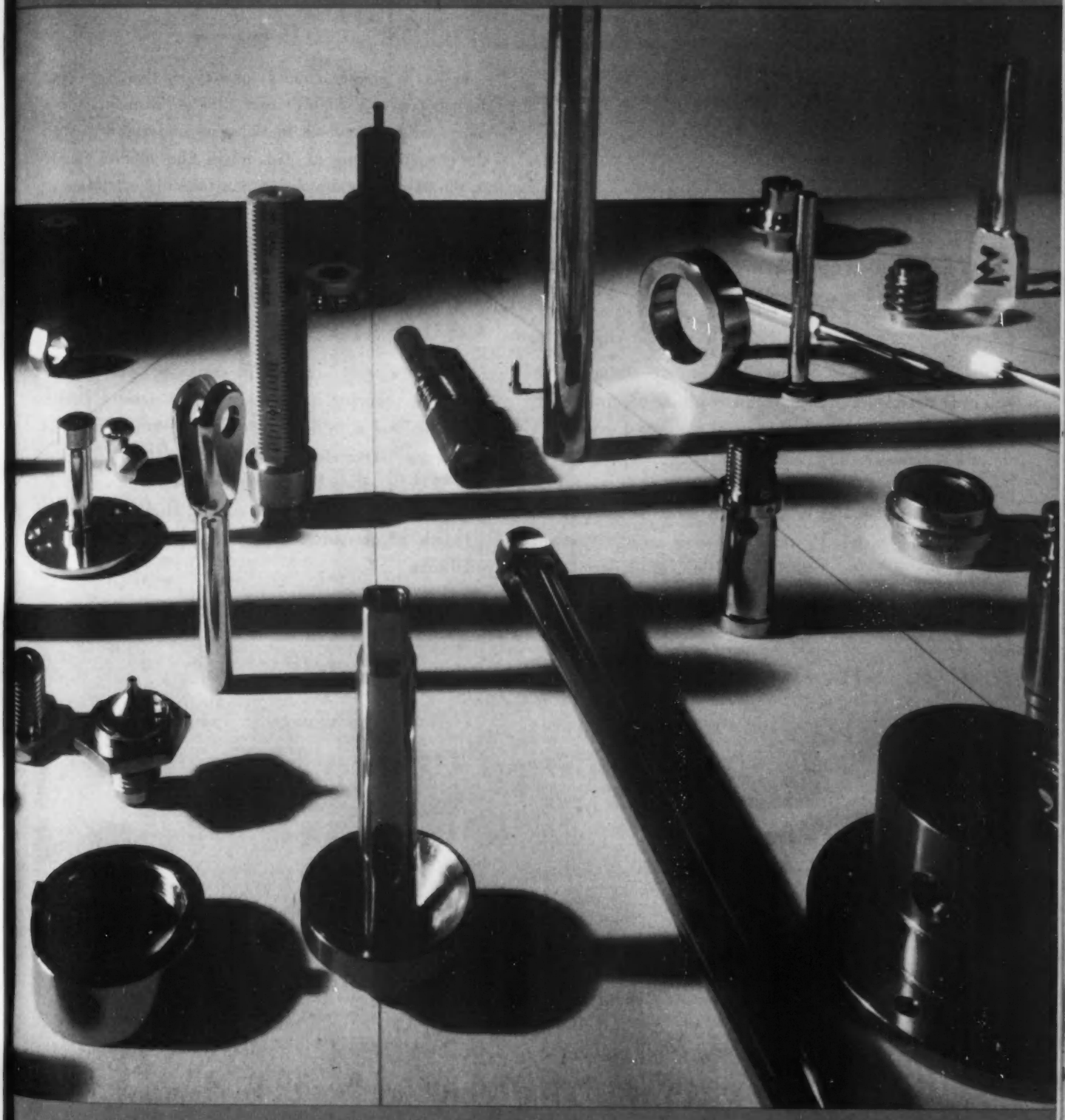
Non-Skid Flooring Made From Thiokol

CONSISTING principally of ground cork and Thiokol synthetic rubber, a non-skid coating known as Flight Floor has been developed by the Glenn L. Martin Company for use on airplane walkways. It weights 47.5 grams per sq. ft. compared with 232.1 grams per sq. ft. for the rubber matting previously used. In developing the coatings one of the chief aims was a material that would be light in weight and still stand up under hard usage. Other factors were good adhesion to metal, plywood and painted surfaces; flexibility and resiliency at —20 to 160 deg. F.; resistance to fire, gasoline, aromatic fuel, oil, de-icer and hydraulic fluids, salt water and oxidation; and ease of repair in the field. It is applied in one coating with a regular open-nozzle paint spray gun. Panels can be stacked after two hours of drying following a light dusting with talc.

Stainless STEELS

FOR PRESENT AND POSTWAR USES

An editorial review of the various types of wrought stainless steels, their properties and typical examples of their use in corrosion-resistant and high-temperature applications.



Stainless STEELS

STAINLESS STEELS are

Alloys of iron and chromium which can withstand corrosive attack of chemicals and atmospheres over a wide range of temperature and pressure. The addition of nickel produces certain desired characteristics. Further special properties are obtained by adding other metals. More than two-thirds the tonnage of stainless steels is iron-chromium-nickel alloys.

CORROSION RESISTANCE REQUIRES

1. Chemical inertness, that is, the relative inability of the metal to combine with or be attacked by the corrosive medium,

or

2. The ability of the metal to form a continuous skin or surface layer of a compound with the adjoining gas, liquid or solid which can arrest the attack and effectively retard further penetration.

Some degree of corrosion resistance is produced even when the alloy contains only small amounts of the protecting metal. However, as soon as it is present above a definite critical proportion, pronounced corrosion resistance results. If metal is subject to electrolytic action, it may or may not corrode, depending on local conditions.

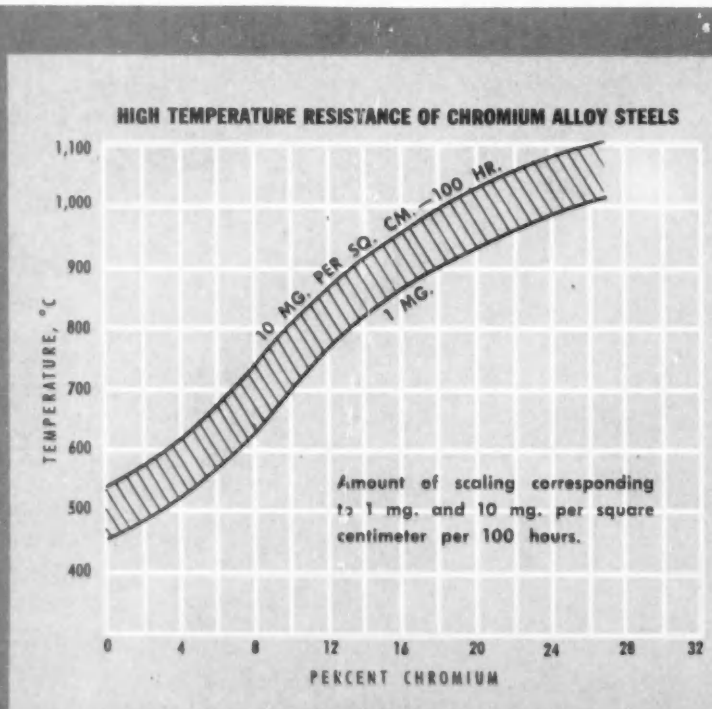
CHROMIUM PROTECTS because

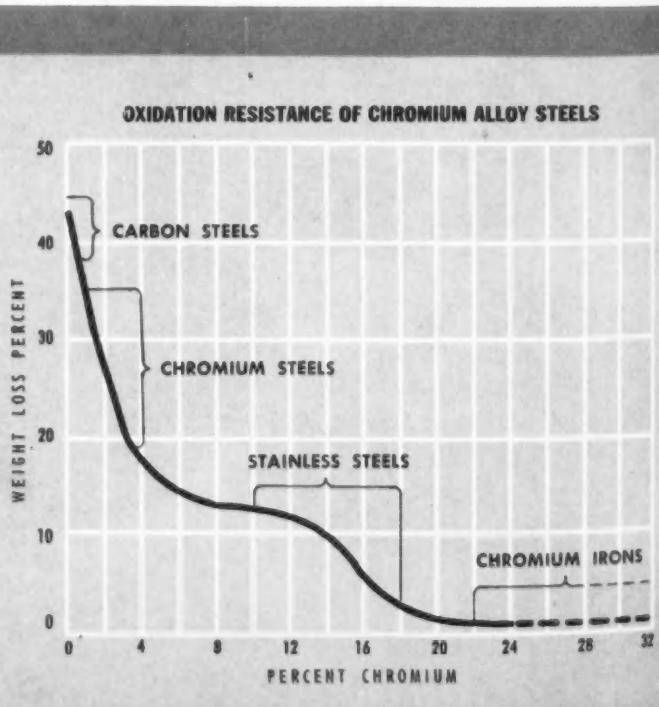
It has a greater affinity for oxygen than iron and forms a strong, highly inert film on iron-chromium alloys which increases in tightness and stability with the chromium content. This tough film adheres firmly to the parent metal and does not tend to grow inwardly, does not peel off, and reforms immediately when rubbed off.

Silicon and aluminum assist chromium.

NICKEL IS MORE INERT THAN IRON

Nickel protects iron against corrosive agents which are of a reducing nature when it is present in the chrome-nickel alloy beyond a definite minimum. The nickel may serve alone in the alloy or it may be supported in its action by other alloying elements, such as manganese, molybdenum, or copper. High-temperature strength of chromium steels is improved by nickel additions.





WROUGHT STAINLESS STEELS ARE DIVIDED INTO THREE GROUPS

Hardenable Chromium, Non-hardenable Chromium and Austenitic Chrome-nickel.

All stainless steels require chromium for true corrosion resistance. The addition of moderate amounts of chromium does not suppress the critical rate of transformation in the iron-chromium alloy. Therefore, moderate chromium content stainless steels permit hardening and are called "hardenable chromium". High-chromium content prevents hardenability in the low-carbon ranges, and high carbon impairs the corrosion resistance. These high-chromium types are referred to as stainless irons or "non-hardenable chromium stainless".

When more than 6- to 7-percent nickel is added, the alloy represents a different modification of iron, a crystal pattern called "austenitic" which has lent its name to this type of steel.

STAINLESS STEEL STANDARDS

(American Iron and Steel Institute, 1944)

Zeros in the hundredth place omitted.

AISI TYPE	C %	Mn Max.%	Si Max.%	P Max.%	S Max.%	Cr %	Ni %	Balance %	APPLICATIONS
HARDENABLE CHROMIUM									
501	Over .10	1.0	1.0	.04	.04	4.0/6.0			Oil industry, tubes, furnace parts
502	.10 max.	1.0	1.0	.04	.04	4.0/6.0			
403	.15 max.	1.0	1.0	.04	.04	11.5/13.0			High tensile strength machinery, turbine blades
405	.08 max.	1.0	1.0	.04	.04	11.5/13.5		Al .1/.3	Valves
406	.15 max.	1.0	1.0	.04	.04	12.0/14.0		Al 3.5/4.5	Electrical resistance wires
410	.15 max.	1.0	1.0	.04	.04	11.5/13.5			Turbine blades
414	.15 max.	1.0	1.0	.04	.04	11.5/13.5	1.25/2.50		Knife blades, tempered rules, mild springs
416	.15 max.	1.0	1.0	x	x	12.0/14.0		x	Free machining, pump shafts, valve stems
420	Over .15	1.0	1.0	.04	.04	12.0/14.0			Cutlery, scissors, knives, pump parts, valves
431	.20 max.	1.0	1.0	.04	.04	15.0/17.0	1.25/2.50		Airplane parts
440A	.60/.75	1.0	1.0	.04	.04	16.0/18.0			Fine knives, surgical instruments
440B	.75/.95	1.0	1.0	.04	.04	16.0/18.0			Valves and bearings
440C	.95/1.20	1.0	1.0	.04	.04	16.0/18.0			Ball bearings, races, valves and valve seats
NON-HARDENABLE CHROMIUM									
430	.12 max.	1.0	1.0	.04	.04	14.0/18.0			Moldings, stampings, trimmings
430F	.12 max.	1.0	1.0	x	x	14.0/18.0		x	Free machining as 430
442	.35 max.	1.0	1.0	.04	.04	18.0/23.0			High temperature applications, furnace parts
443	.20 max.	1.0	1.0	.04	.04	18.0/23.0		Cu .90/1.25	Furnace parts, non-ferrous metal ladles, stirrers
446	.35 max.	1.0	1.0	.04	.04	23.0/27.0			High temperature resistance, low strength
AUSTENITIC Cr-Ni									
301	Over .08 Max. .20	2.0	1.0	.04	.04	16.0/18.0	6.0/8.0		Household articles, appliances
302	Over .08 Max. .20	2.0	1.0	.04	.04	17.0/19.0	8.0/10.0		Moldings, stampings, wire, screens, springs
302B	Over .08 Max. .20	2.0	2.0/3.0	.04	.04	17.0/19.0	8.0/10.0		As 303, for high temperature service, furnace parts
303	.20 max.	2.0	1.0	x	x	17.0/19.0	8.0/10.0	x	Free machining as 302
304	.08 max.	2.0	1.0	.04	.04	18.0/20.0	8.0/10.0		Welding of light sections
308	.08 max.	2.0	1.0	.04	.04	19.0/21.0	10.0/12.0		Deep drawing special, also welded parts
309	.20 max.	2.0	1.0	.04	.04	22.0/24.0	12.0/15.0		Oil burner parts, refinery and chemical plant
310	.25 max.	2.0	1.5	.04	.04	24.0/26.0	19.0/22.0		Heat resistance, furnace parts, pumps
316	.10 max.	2.0	1.0	.04	.04	16.0/18.0	10.0/14.0	Mo 1.75/2.50	Special high temperature and corrosion service
321	.10 max.	2.0	1.0	.04	.04	17.0/19.0	8.0/11.0	Ti = 4xC Min.	For welded parts
347	.10 max.	2.0	1.0	.04	.04	17.0/19.0	9.0/12.0	Cb = 10xC Min.	For welded parts and electrodes

Note: No specific composition limits should be placed on type 301, 302, 302B and 303, except that carbon may be specified to a 4-point range within the above limits.

x Free machining stainless steels: (P or S or Se Min. 0.07; Zr or Mo Max. 0.60).

HARDENABLE CHROMIUM *Stainless*

5 Cr

Hardenable *Not work-hardening*
Machinability: Good *Weldability: Good*

Corrosion retarded to about one-fifth the rate of ordinary steel. Has high creep strength up to 900 deg. F. and scale resistance to 1,000 deg. F. Molybdenum is almost always present, about 0.5 percent, and sometimes minor alloying agents such as W, Cu, Al, up to 1 percent. Some non-hardenable grades contain Cb or Ti, and low carbon. Largely used in oil-refinery work, in preheater tubes, bubble caps, furnace parts and still bottoms, even in the processing of very sour crudes.

★ ★ ★

Steel in this same group with 7- to 9-percent Cr with Mo is used for somewhat more severe conditions in the same applications as 5-percent Cr type. Modified steels, containing either Al or Si (about 3 percent) and 0.5-percent C, are used as valves in internal-combustion engines.

13 Cr

Hardenable *Not work-hardening*
Machinability: Fair *Weldability: Good*

Steels in this group are the lowest priced of the true stainless steels. Low-carbon 13-Cr steels combine high strength and elasticity with toughness and workability. Weldability is impaired as Cr increases beyond 13 and C beyond 0.20 percent. Steels resist softening up to 700 deg. F., scaling to 1,400 deg. F. and retain considerable creep strength at 1,000 deg. F. These steels resist corrosion from the atmosphere, fresh and certain mine waters, steam, carbonic acid, crude oil, blood, perspiration, mercury, soap and sugar solutions. They are used for turbine blades, and for valve trim in steam and oil services. Specially adjusted grades, 13.5 Cr and 0.08 C are not hardenable.

★ ★ ★

Modification with 2-percent Ni develops higher tensile values in the heat-treated condition combined with good corrosion resistance.

The 13-Cr steel with 0.30-percent C is regular cutlery grade with good corrosion resistance in the hardened condition. Used also for instruments, valves, pistons, shafts and ball bearings.

Free-machining type is available with P, S, or Se, and Mo added. 13 Cr is never used at minus temperatures where impact stresses may occur. High electrical and scaling resistance is produced by alloying with 4-percent Al, making it non-weldable and non-hardenable. Used for electric resistance windings. Also, a smaller addition of Al makes the alloy non-hardenable but in this case excessive heating causes pronounced grain growth and lowered toughness.

High carbon grades from 0.40-percent C and higher.

17 Cr

Hardenable *Not work-hardening*
Machinability: Fair *Weldability: Fair*

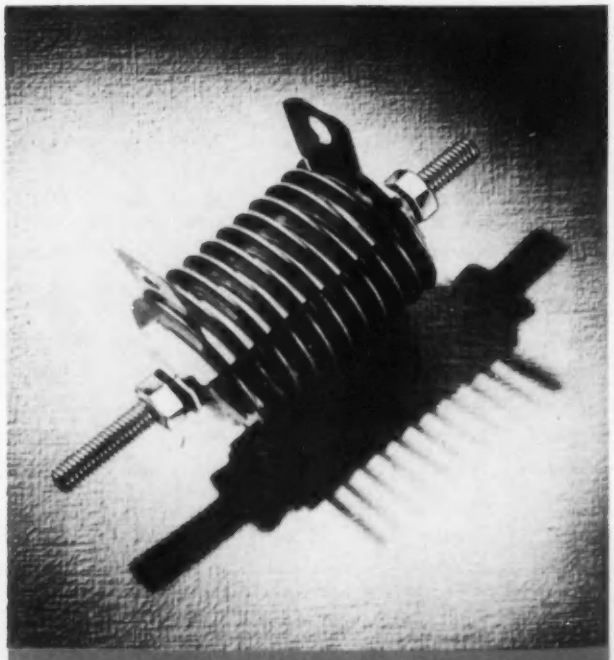
The 0.7-percent C is best stainless cutlery grade, hard and wear resistant, excellent for surgical instruments and trade knives. High carbon somewhat impairs corrosion resistance which is slightly inferior to that of low-carbon 13 Cr.

The 1.0-percent C steel combines maximum hardness with anti-corrosion qualities. Uses: Valves, ball bearings and in the oil industry.

Low-carbon grades are non-hardenable.

★ ★ ★

Alloyed with 2-percent Ni and with low carbon content this steel develops good heat-treating, tensile impact and corrosion-resisting properties, especially against electrolytic corrosion in contact with some non-ferrous metals in the presence of sea water, and similar electrolytes.



Edge-wound resistor coil depends on the uniform resistance and easy forming qualities of type 406 Al-bearing stainless.

Low carbon up to 0.12 percent

17 Cr

Not hardenable by heat-treatment
Machinability: Fair
Limited work-hardening
Weldability: Fair

Corrosion resistance is considerably improved over 13-Cr irons, especially against nitric acid and milk. Oxidation resistance extends to 1,600 deg. F. Steel is ductile and lends itself to complicated press work, does not work harden as much as 18/8. A high polish is easily attained. While thin sections can be welded easily, the steel is not generally recommended for heavy welding because of excessive grain growth above 1,800 deg. F. Stainless iron is used for trimming automobiles, cameras and electric appliances. It is important in industrial machinery and equipment for the nitric-acid industry, in rubber, oil, ice making, bakery and meat-packing industries; for septic and other tanks, scientific apparatus and instruments; blowers; burners; and bolts, nuts and studs.

This material is also supplied in a free-machining variety which contains sulphur or selenium, and molybdenum in small quantities. Sometimes a lower Cr content (15 percent) is preferred for intermediate corrosion resistance and mechanical properties.

20 Cr

Not hardenable by heat-treament
Machinability: Fair
Limited work-hardening
Weldability: Fair

This material is similar to 17-Cr stainless iron, but it remains non-scaling up to 1,800 deg. F. and has slightly better corrosion resistance. The grain growth above 1,800 deg. F. becomes increasingly pronounced as Cr exceeds 18 percent.

NON-HARDENABLE CHROMIUM *Stainless*

The addition of 1-percent Cu improves resistance to scaling and corrosion in some media. The material is free from intergranular corrosion effects and is machined more easily than austenitic stainless. In some respects the anti-corrosion features, especially towards sulphuric acid are also better, but halogen acids attack the steel severely.

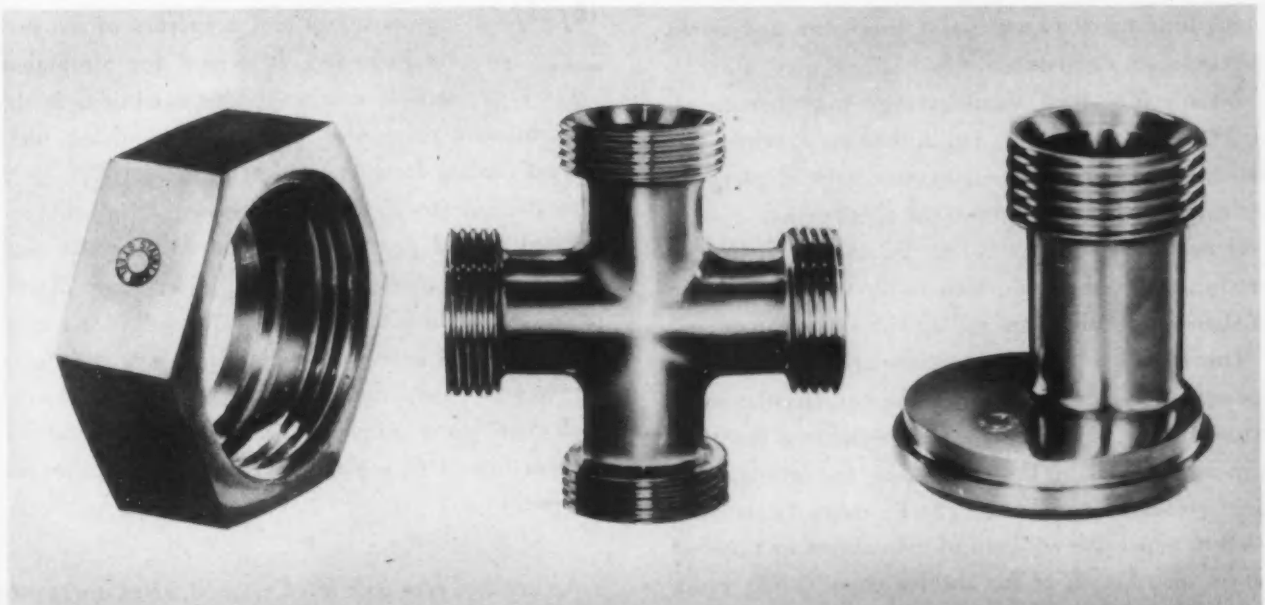
Ladles for non-ferrous metals, furnace parts and such items are made from it.

28 Cr

Not hardenable by heat-treatment
Machinability: Poor
Slightly work-hardening
Weldability: Poor

Among most heat and corrosion resisting of wrought stainless steels. Resists oxidation up to 2,000 deg. F. Used safely up to 1,900 deg. F., but hot strength is low and alloy tends to be brittle after exposure to high temperatures. Used in applications where acid mine waters, sulphur gases or mixed acids are encountered at high temperatures. Some special analyses have been developed with about 5-percent nickel and 2-percent molybdenum for the most severe anti-corrosion service to which wrought ferrous materials are exposed.

Recent work shows that toughness of 28 Cr can be improved by small nickel and fractional N_2 additions.



Fittings made from stainless steel are available in many shapes and sizes. Shown are a cross with all ends threaded, a union nut of the hexagon type, and an eccentric reducer, plain on the large end and threaded on the small end.

AUSTENITIC Cr-Ni *Stainless*

AUSTENITE is a modification of iron. It can exist at room temperature only by alloying steel with certain elements, such as nickel, manganese, copper, nitrogen. Completely austenitic iron, produced by quenching from about 2,000 deg. F., is non-magnetic, tough and highly ductile. But the modification in which iron occurs has little influence on the corrosion resistance of the alloy. Depending on its degree, cold-work converts austenite more or less completely to martensite, which explains work-hardening. Various types of austenitic stainless steels can be fabricated, machined, formed, welded, as easily or almost as easily as plain carbon steel if the choice is made to suit the method of fabrication.

18/8

Not hardenable by heat-treatment
Machinability: Poor; good for some alloys
Work-hardening
Weldability: Good; precautions

Standard austenitic stainless (18 Cr, 8 Ni) keeps silvery surface under all atmospheric conditions and is immune to foodstuffs, to most organic and a great many inorganic chemicals, to dyes and sterilizing solutions. Scale resistance is excellent up to 1,600 deg. F., grain growth begins at 1,800 deg. F. Steel has good deep-drawing properties but poor machinability. There are some modifications containing sulphur or selenium, and molybdenum, which have excellent machining properties and retain the corrosion resistance of 18/8.

When cold-worked, tensile strength may increase up to 300,000 lb. per sq. in., i.e. in the case of wires, and the strength/weight ratio makes the material attractive for airplane or other lightweight construction.

If held at 800 to 1,400 deg. F., chromium carbide precipitates on the grain boundaries and opens a line of attack to chemicals and to "intergranular corrosion."

This effect, which is of great importance in welding operations and in high-temperature equipment, can be avoided by: (1) Using stainless containing less than 0.08-percent carbon, thus preventing the formation of large amounts of carbides; (2) by using "stabilized" 18/8 in which the addition of columbium or titanium causes distribution of the carbide deposit; (3) redissolving the carbides in a subsequent anneal at 1,900 deg. F., that is, after precipitation but before chemical corrosion has set in.

Uses for this steel are widespread and include architectural trimmings and fittings, meat packing, hotel, dairy and restaurant equipment, airplanes and railroad equipment. Welded constructions to be exposed to severe corrosion stresses are made of low-carbon 18/8 (C below 0.08 percent), or better of stabilized 18/8 (Cb = 10 × C; or Ti = 4 × C).

★ ★ ★

The 17/7 steel is similar, but range of application is somewhat more limited. Here austenite is not as stable and steel work-hardens more easily to high tensile values. Free-machining 18/8 stainless contains 0.07 min. of S or Se and 0.60 max. of Mo, and has improved machining properties while retaining the corrosion resistance of the unmodified material.

★ ★ ★

A recent development is the austenitic 18/4/4 or 18/5/5 steel containing Cr/Ni/Mn. It is said to have good forming qualities combined with excellent corrosion resistance which is superior to 18/8 in respect to sulphur-bearing gases.

18/11/2

This material is essentially the same as 18/8, but with 18 Cr, 11 Ni, 2 Mo the corrosion resistant properties of the steel are improved. It is used for continuous service under corrosive conditions in the embrittlement range. For applications requiring intermittent cooling from the critical temperature range, a Cb-stabilized modification is specified. Originally developed for the paper industry, this type is also used in textile and chemical work in the presence of sulphite, dye or bleaching solutions. This grade is most frequently used to resist the attack of heavy chemicals, also in cases where wetting and aeration are combined, such as in foams in mixers or cookers, or where solids, such as bits of pulp and impurities, are deposited on the metal.

★ ★ ★

An inverted type with 8½ Cr, 22 Ni, 1¼ Cu was one of the first austenitic steels. It is still used on oil pumps

and for its resistance to sulphuric acid, soda ash and calcium-chloride brine.

24/12

Not hardenable by heat-treatment
Machinability: Poor
Work-hardening
Weldability: Good; precautions

This group of high-strength materials is a further development of the 18/8 type. Protection against corrosion covers the same range of agents but extent of protection is greater. After welding or after prolonged service in the embrittlement range 900-1,600 deg. F., parts should be thoroughly annealed at 1,900 deg. F. Material is too tough for extensive machining, but drawing, forming, upsetting and forging are being performed.

Often 2½ Si is added for greater high-temperature protection.

* * *

25/20 extends this series still further to 25-percent Cr and 20-percent Ni. The good welding properties and the possibility of upsetting and drawing make this steel standard material for heavy high-temperature service (except 900-1,600 deg. F.) in the chemical industry.

* * *

20/25 is a similar alloy with 20-percent Cr, 25-percent Ni, 2½-percent Si for high-temperature corrosion applications. It is also subject to embrittlement. Fabrication difficulties, apart from welding, are even more pronounced. Resistance to SO_3 is better than that of other steels in this group. Used for furnace parts, retorts, tubes. After service in embrittlement range, 25/20 and 20/25 are reannealed at 1,900 deg. F.

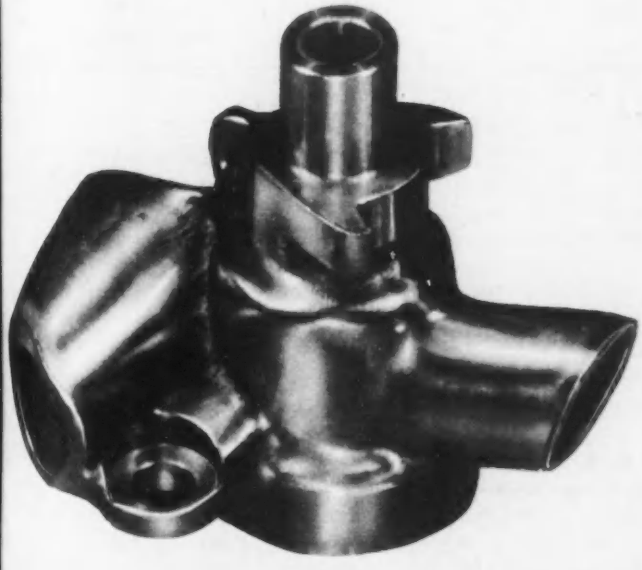
* * *

THREE FORMS OF EMBRITTLEMENT must be clearly defined and understood:

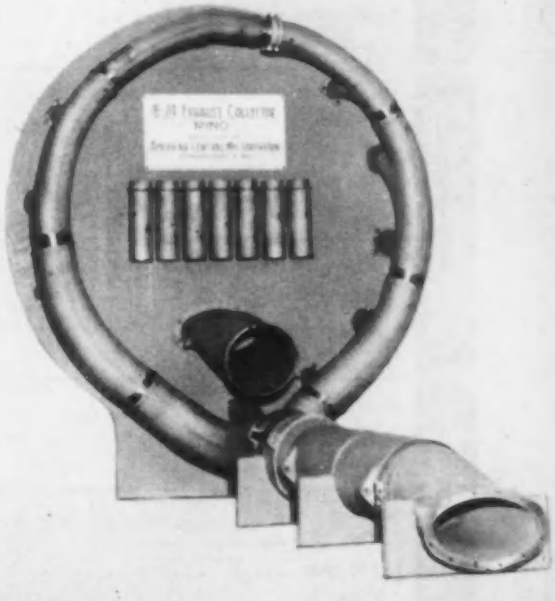
(1) Cr-Ni steels are subject to carbide precipitation when held between 900 and 1,400 deg. F., as discussed above. This effect results in "intergranular corrosion"; that is, embrittlement after corrosion has taken place either at elevated or at room temperature after cooling. It must be corrected before corrosion has set in. No corrections are possible once the material has become embrittled under chemical attack.

(2) Highly alloyed austenitic Cr-Ni steels undergo a phase change at 1,400 to 1,600 deg. F. which makes them brittle at any temperature up to 1,600 deg. F. Simple reheating to 1,900 deg. F. will recondition the material.

(3) Straight chromium stainless experiences pronounced grain growth above 1,800 deg. F. which results in embrittlement. If this process is permitted to proceed too far, only forging can correct it and break down the overgrown grain.



Body of fuel supply valve is forged and machined from chromium-nickel stainless steel to withstand the corrosive action of high-octane fuels.



Exhaust collector rings for Liberator bombers are made of stabilized 18 8 stainless steel to withstand corrosion of hot combustion gases.

STAINLESS STEELS—PHYSICAL PROPERTIES

	GROUP	COMPARISON	HARDENABLE CHROMIUM			
	TYPE AISI	SAE 1020	501	410[a]	440 A	431
CHEMICAL ANALYSIS*	Chromium, Percent		Cr 5	Cr 13	Cr 17	Cr 17
	Nickel, Percent		–	–	–	Ni 2
	Carbon, Percent		C 15	C 10	C .75	C .15
	Others, Percent					
PHYSICAL PROPERTIES	Modulus of Elasticity, 10^6 lb./sq. in.	30	29	29	29	30
	Density....lb./cu. in.	0.283	0.280	0.280	0.280	0.280
	Specific resistance @ 68°F. microhms/cu. in.	4.32	16.8	22.4	23.6	29.0
	Melting range....°F.	2,710-2,790	2,760-2,800	2,725-2,750	–	–
	Magnetic permeability, as annealed		FERRO-MAGNETIC			
	after 10% reduction of area					
	Specific heat....B.T.U./°F./lb. (32-212°F.)	0.105	0.110	0.160	0.110	0.110
	Thermal conductivity B.T.U./sq. ft./hr./°F./in. @ 212° F.	335	246	173	–	–
	@ 932°F.	–	206	184	–	–
	Coefficient of thermal expansion per °F. x 10^6 (32-212°F.)	6.5	6.4	6.1	–	6.4
MECHANICAL VALUES at Room Temperatures	Hardness, Brinell, annealed	120-140	140-170	135-165	190-240	230-260
	Heat treated	–	250-300	202-390	500-620	230-400
	Cold rolled	–	–	–	–	–
	Ultimate Tensile, 1,000 lb./sq. in., annealed	55-65	60-80	85-100	95-110	105-120
	Heat treated	–	120-145	100-200	125-300	120-180
	Cold rolled	–	–	–	–	–
	Yield point, 1,000 lb./sq. in., annealed	35-45	25-35	60-75	60-65	85-95
	Heat treated	–	100-135	60-175	100-250	100-145
	Cold rolled	–	–	–	–	–
	Elongation in 2 in., percent, annealed	40-30	40-30	35-25	30-20	30-20
	Heat treated	–	20-15	30-10	15-1	25-15
	Cold rolled	–	–	–	–	–
	Reduction of area, percent, annealed	70-60	80-60	75-60	50-35	65-55
	Heat treated	–	60-50	75-50	30-3	60-45
	Impact strength, Izod, ft.-lb., annealed	70-40	80	110-80	20-5	100-60
	Heat treated	–	30	100-20	6-2	80-30
	Ductility, Olsen, inches, annealed	0.425-0.350	–	0.4-0.3	–	–
	Erichsen, mm., annealed	–	8	8-7	–	–
MECHANICAL VALUES At Elevated Temperatures	Creep strength, 1% elongation in 10,000 hr.					
	@ 1,000 deg. F., 1,000 lb./sq. in.	4.5	9	13	–	–
	@ 1,100 deg. F., 1,000 lb./sq. in.	2.0	4.8	5	–	–
	@ 1,300 deg. F., 1,000 lb./sq. in.	0.7	–	1.5	–	–
	@ 1,500 deg. F., 1,000 lb./sq. in.	–	–	0.7	–	–
	Strength at elevated temperatures, 1,000 lb./sq. in.					
	Short time tests 1,300 deg. F.	–	18	17	–	25
	1,500 deg. F.	–	12	8.4	–	10
	1,700 deg. F.	–	–	8	–	–
HEAT TREATMENT In Degrees Fahrenheit	Annealing[1]	1,600; AC	1,550; FC	1,550-1,650; FC[2]	1,625-1,675; FC[2]	1,150-1,225; AC
	Hardening[1]	1,575-1,650; Q	1,650; AC/OQ	1,750-1,800; AC/OQ	1,850-1,900; AC/OQ	1,800-1,950; AC/OQ
	Tempering[1]	300-1,400; AC	1,000-1,300; AC	1,000-1,400; AC	300-700; AC	1,000-1,200; AC
	Forging—Start	2,000	2,100-2,200	2,100	2,000-2,100	2,150
	Finish	1,400	1,400	1,450 +	1,750 +	1,700 +

* For specifications and ranges of chemical composition see page 3.

[a] Free machining types 416, 430F and 303 containing P, S or Se 0.07 percent min., Mo 0.60 percent max. follow their prototypes 410, 430 and 302 closely in physical properties and mechanical characteristics.

AND MECHANICAL CHARACTERISTICS

NON-HARDENABLE CHROMIUM			AUSTENITIC CHROME-NICKEL					
430[a]	442	446	302	303[a]	321/347	316	309	310
CR 17 – C .10	Cr 20 – C .20	Cr 28 – C .20	Cr 18 Ni 8 C .15	Cr 18 Ni 8 C .15 S/Se, Mo	Cr 18 Ni 8 C .08 Ti/Cb	Cr 18 Ni 11 C .08 Mo 2	Cr 24 Ni 12 C .15	Cr 25 Ni 20 C .20
29 0.280 23.6 2,710-2,730	29 0.279 26.0 2,650	29 0.274 26.5 2,650-2,700	29 0.286 27.6 2,550-2,600	29 0.286 27.6 2,550-2,600	29 0.288 28.0 2,550-2,600	28.5 0.288 28.5 2,500-2,550	30 0.284 30.0 2,500-2,550	30.5 0.288 30.5 2,500-2,600
FERRO-MAGNETIC			1.003 1.10	1.003 1.10	1.003 1.10	1.003 1.10	1,003 1,003	1.003 1.003
0.150 156 170 5.7	0.110 151 169 5.4	0.144 140 162 5.3	0.118 110 150 9.0	0.118 110 148 9.0	0.118 110 150 8.8	0.118 108 147	0.118 92.5 113 8.0	0.118 – – 8.0
145-185 – 185-270	150-175 – –	160-200 – –	135-185 180-330	130-150 – 180-330	135-185 – 180-300	135-185 – 180-300	170-200 – –	145-210 – –
75-85 – 90-130	75-85 – 90-130	80-90 – –	80-90 – 100-180	80-90 – 100-150	80-90 – 100-180	80-90 – 100-150	90-110 – –	90-110 – –
35-45 – 65-120	35-45 – 65-120	50-65 – –	35-45 – 50-150	35-45 – 50-120	35-45 – 50-120	35-55 – 50-125	35-45 – –	40-50 – –
40-25 – 20-2	40-30 – 20-2	30-20 – –	60-55 – 50-10	60-55 – 50-10	60-55 – 50-10	70-60 – 50-15	55-40 – –	55-45 – –
60-50 –	60-50 –	60-40 –	70-60 –	70-55 –	70-60 –	70-60 –	65-50 –	60-50 –
60-10 –	60-10 –	10-1 –	140-115 –	80-75 –	140-115 –	120-70 –	105-80 –	80-50 –
0.4-0.3 9-7	– 9-7	– –	0.5-0.4 14-11	– –	– –	– –	– –	– –
8.5 5 1.4 0.6	8.5 5 1 0.6	6.5 3.5 0.8 –	18.3 11.5 3.5 0.8	18.3 11.5 3.5 0.8	18.5 14 6 1	25 20 10 3	15 10 4.5 1	17 13 4.5 1.1
19 9 7	20 10 7	22.5 11 6	37.5 22.3 12	37.5 22.3 12	42 26 15	45 30 18	55 34 16	45 28 13
1,450-1,550; AC/WQ	1,450-1,550; AC/WQ	1,450-1,550; AC/WQ	1,950-2,050; Q	1,800-2,050; Q	1,700-1,950; Q	1,850-2,050; Q	1,850-2,050; Q	1,900-1,950; Q
NON-HARDENABLE								
1,900-2,050 1,300-1,500	1,900-2,050 1,300-1,500	1,900-2,050 1,300-1,500	2,100 1,700 +	2,100 1,700 +	2,100 1,800 +	2,200 1,700 +	2,150 1,800 +	2,150 1,800 +

AC=Air Cool FC=Furnace Cool WQ=Water Quench OQ=Oil Quench

[a] Or 1,350-1,450; AC.

This table has been compiled from published and from research laboratories' data, where divergencies occurred a compromise has been attempted.

STAINLESS STEELS — CORROSION RESISTANCE

Particular applications should in each case be brought to the attention of supplier and all conditions stated, as too many variables are involved in corrosion work to permit generalizations

GROUP	HARDENABLE CHROMIUM				NON-HARDENABLE Cr			AUSTENITIC Cr – Ni				
AISI TYPE	501	410[a]/420	440	431	430[a]	443	446	302[a]	321/347	316	309	310
Cr, Percent	Cr 5	Cr 13	Cr 17	Cr 17	Cr 17	Cr 20	Cr 28	Cr 18	Cr 18	Cr 18	Cr 24	Cr 25
Ni, Percent	....	....	....	Ni 2	....	....	....	Ni 8	Ni 8	Ni 11	Ni 12	Ni 20
Others, Percent	C .15	C .10/.30	C 1.00	C .15	C .10	C .15	C .25	C .15	Ti/Cb	Mo 2	C .15	C .15
Relative Cost[1], SAE 1.020 Bars & Structurals 1.0	3.7	8.6/11.2	11.2	8.8	8.8	10.5	12.8	11.2	13.5/15.3	18.6	16.7	22.8
ATMOSPHERE												
Rural	F	G	G	G	E	E	E	E	E	E	E	E
Seashore	F	FG	G	G	G	G	G	E	E	E	E	E
Industrial	F	G	G	G	G	G	G	E	E	E	E	E
WATER												
Domestic	F	G	G	G	G	G	E	E	E	E	E	E
Mine	P	F	FG	G	G	G	G	E	E	E	E	E
Sea[2]	P	F	F	FG	F	F	F	F	F	G	F	F
Saline with H_2S[2]	P	F	F	F	F	F	F	F	F	G	F	F
Brackish with MCl	P	F	F	G	G	F	G	G	G	E	G	G
Wet Steam	F	G	E	E	G	E	E	E	E	E	E	E
OXID. RESIST. Max. Safe Temp. °F.												
Oxidizing Gases	1,200	1,400	....	....	1,600	....	1,900	1,550	....	..	..	..
Reducing Fuel Gas	1,200	1,400	....	....	1,600	....	1,900	1,550	....	..	..	..
Sulphur-Rich Gas	1,200	1,400	....	....	1,500	....	1,800	300/1,300	....	..	..	..
ACIDS, Room Temp. (5-15% Conc.)												
Hydrochloric[3]	P	P	P	P	P	P	P	P	P	P	P	P
Sulphuric[3]	P	P	P	P	P	P	P	P	P	G	P	P
Nitric[3]	P	G	G	E	E	E	E	E	E	E	E	E
Acetic[3]	P	G	G	E	E	E	F	E	E	E	E	E
Phosphoric[3]	P	F	F	F	F	F	G	G	G	E	G	G
ALKALIES												
Solutions (1-20%)[3]	G	E	E	E	E	E	E	E	E	E	E	E
Fused (NaOH at 318 deg. F.)	P	P	P	P	P	P	P	F	F	F	F	F
ORGANIC CHEMICALS												
Carbon Disulphide	P	G	G	E	E	E	E	E	E	E	E	E
Carbon Tetrachloride	P	G	G	E	E	E	E	E	E	E	E	E
Ethyl Alcohol, or Chloride, Ester	P	G	G	E	E	E	E	E	E	E	E	E
Glycerine	P	G	G	E	E	E	E	E	E	E	E	E
Phenols and Phenolates	P	G	G	G	G	G	E	E	E	E	E	E
OIL REFINERY												
Crudes below 400 deg. F. Sweet	G	E	E	E	E	E	E	E	E	E	E	E
Crudes below 400 deg. F. Sour	G	E	E	E	E	E	E	E	E	E	E	E
Oils, Mineral and Vegetable[4]	G	E	E	E	E	E	E	E	E	E	E	E
FOOD & BEVERAGE INDUSTRIES												
Fruit and Vegetable Juices	P	G	G	G	G	G	E	GE	E	E	E	E
Beer	P	E	E	E	E	E	E	E	E	E	E	E
Carbonated Beverages	P	E	E	E	E	E	E	E	E	E	E	E
Meats	P	E	E	E	E	E	E	E	E	E	E	E
Dairy Products	P	F	F	G	G	G	G	E	E	E	E	E
Syrup	P	G	E	E	E	E	E	E	E	E	E	E
MISCELLANEOUS CHEMICAL INDUSTRIES												
Hot Sulphite Liquor	P	F	F	F	F	F	GE	GE	GE	E	GE	GE
Dye Liquor	P	P	P	F	F	F	F	FG	FG	E	E	E
Ammonia (Aq. Sol.)	P	E	E	E	E	E	E	E	E	E	E	E
Ammonia, H_2, N_2 (Gas Mixt.)[5]	GE	P	P	..	P	P	P	GE	..	..	GE	..
Soaps	P	E	E	E	E	E	E	E	E	E	E	E

[1] Relative cost is based on Bars and Structurals for SAE 1020 as 1.0. Base f.o.b. Pittsburgh for all grades without extras for surface conditions, tolerances, heat treatment, size, quantity, pickling, etc.

[2] Chance of pitting.

[3] Worst condition over range as defined.

[4] Including: Mineral and Vegetable, gasoline, paraffine, naphtha, linseed, soybean, tung.

[5] Gas mixture as occuring in synthetic ammonia production, type 501 contains ¼ percent of V and is GE up to 950 deg. F., 302 and 309 up to 1050 deg. F.

[a] Free-machining grades 416, 430F and 303 essentially as their prototypes, 410, 430 and 302 respectively.

E – Excellent, almost unlimited service.

G – Good, will give good service.

F – Fair, only to be used in temporary construction.

P – Poor.

FG – Fair to Good, etc.

STAINLESS STEELS — PROPERTIES IN FABRICATION

GROUP	HARDENABLE CHROMIUM				NON-HARDENABLE Cr			AUSTENITIC Cr – Ni					
AISI TYPES	501	410[a]/420	440	431	430[a]	443	446	302	303	321/347	316	309	310
Cr, Percent	Cr 5	Cr 13	Cr 17	Cr 17	CR 17	CR 20	CR 28	CR 18	CR 18	CR 18	Cr 18	Cr 24	CR 25
Ni, Percent	....	....	....	Ni 2	....	....	....	Ni 8	Ni 8	Ni 8	Ni 11	Ni 12	Ni 20
Others, Percent	C .15	C .10/.30	C 1.00	C .15	C .10	C .15	C .25	C .15	S/Se, Mo	Ti/Cb	Mo 2	C .15	C .15
Air Hardening	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
Anneal @ Deg. F.	1,550	1,600	1,650	1,200or1,400	1,450	1,450	1,450	1,900	1,900	1,900	1,900	2,050	1,900
Cool in[1]	FC	FC	FC	AC	AC	AC/WQ	AC/WQ	WQ	WQ	WQ	WQ	WQ	WQ
Blanking	G	G	F	F	G	✓	✓	F	G	F	F	F	F
Brazing[2]	✓	✓	✓	✓	✓	✓	✓	F	No	✓	F	F	F
Buffing	✓	✓	✓	✓	✓	✓	✓	✓	✓	P	✓	✓	✓
Coining (Cold)	F	F	P	P	G	G	F	G	F	G	F	F	F
Deep Drawing	F	PF	P	No	G	F	F	G	No	G	F	F	F
Embossing	F	G/PF	No	P	G	G	G	G	F	G	F	F	F
Forging (Hot)	G	FG	F	FG	✓	✓	F	G	F	FG	FG	FG	✓
Forging (Cold)	G	FG	PF	F	✓	✓	F	G	FG	FG	G	FG	FG
Forming (Hot)	G	FG	F	FG	✓	✓	F	G	F	FG	FG	FG	✓
Forming (Cold)	G	FG	PF	F	✓	✓	F	G	FG	FG	G	FG	FG
Grinding	G	G	G	G	F	F	F	F	G	F	F	F	F
Hardening @ Deg. F.	1,650	1,825	1,900	1,900	No	No	No	No	No	No	No	No	No
Quench in[1]	AC/OQ	AC/OQ	OQ	OQ	–	–	–	–	–	–	–	–	–
Heading (Hot)	G	FG	F	FG	✓	✓	F	G	PF	F	F	F	PF
Heading (Cold)	G	FG	P	FG	✓	✓	F	G	F	F	G	F	F
Machinability	G	F	F	FG	F	F	F	P	G	P	P	P	P
Magnetic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Punching (Perforating)	✓	F	F	F	F	F	F	PF	F	PF	P	P	P
Polishing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rivet (Hot)	✓	No	No	No	Below1,400 ✓	✓	✓	✓	PF	✓	✓	✓	✓
Rivet (Cold)	FG	PF	PF	PF	✓	✓	✓	✓	PF	✓	✓	✓	✓
Shearing (Cold)	✓	✓	F	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Soldering (Soft)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Soldering (Hard)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Spinning	PF	No	No	F	F	F	F	G	PF	G	PF	PF	PF
Spotting (Hot)	G	FG	F	FG	✓	✓	F	G	PF	F	F	F	PF
Spotting (Cold)	G	FG	P	FG	✓	✓	F	G	F	F	G	F	F
Welding	✓	F	F	F	F	F	F	G	No	G	G	G	G
In Hot Working Operations, Look Out for:	–	Air Hardening		–	–	Grain Growth		–	Intergranular Cor.		–	Intergranular Corrosion	

AC=Air Cool FC=Furnace Cool WQ=Water Quench OQ=Oil Quench

[2] Caution should be used in brazing or hard soldering stainless steel.

[a] Free machining grades available (416, 430F), as 303 for 302, Machinability is "G", Welding "G", Forming Operations Poorer and Welding "No".

NOTE: Good (G), Fair (F), Passable (✓), Slight (PF), Poor (P) are relative among the several stainless steels and these ratings should not be extended to comparisons with other materials.

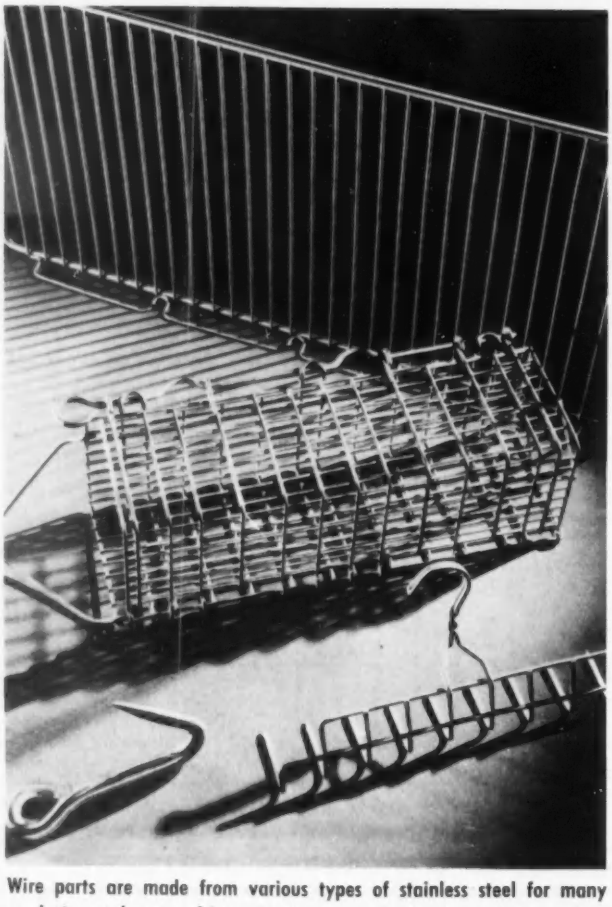
Passable (✓) means that this operation presents no difficulties which should prevent the selection of the particular steel.

For specifications and ranges of chemical composition of steels in these tables see page 3, Stainless Steel Standards.

WELDABILITY

Straight Chromium Stainless has little ductility after welding and weld seams will not stand excessive deformation or bending. Welds on hardenable-Cr stainless can be fully annealed at about 1,400 deg. F. However, at temperatures above 200 to 500 deg. F. even unannealed welds attain considerable toughness, and steels with more than 18-20-percent Cr are welded in a preheated condition at about 400 deg. F. These alloys are stressed-relieved by annealing at about 1,400 deg. F. They are prone to extremely rapid grain growth above 1,800 deg. F.

The comparatively low heat expansion of these steels frequently determines their selection. For instance, when sidesheets for locomotive fireboxes were made of 18-percent Cr steel, they showed no signs of corrosion, cracking or buckling after a service life which completely outwore mild steel. The rate of heat expansion of austenitic 18/8 made its use inadvisable.



Wire parts are made from various types of stainless steel for many products, such as refrigerator trays, meat hooks and tie racks.

Austenitic Cr-Ni stainless can be welded by any method, except forge or fire welding. It is tough and ductile in the as-welded condition. However, the tendency to embrittlement between 900 and 1,400 deg. F. makes special precautions necessary. After welding ordinary austenitic steel with more than 0.08-percent C, it should be heated to about 1,900 deg. F. and cooled rapidly. Air-cooling suffices only for cross-sections of 1/16 in. or less. Low C (0.10 percent) is used with Cb or Ti as a stabilizer, if the parts are exposed to the dangerous temperature range in service. If heavy corrosion stresses are exerted in addition, then 18 Cr, 11 Ni, 2 Mo is required. Compared with mild steel, 18/8 has 160 percent of the thermal expansion, 40 to 50 percent of the heat conductivity, six times the electrical resistance and a lower melting point.

Electric arc welding is generally used with reversed polarity, electrode positive, work negative. Electrode is coated and contains less than 0.08 percent C. Its chemical composition is usually the same as that of the work. A non-carbonaceous flux is needed to protect the chromium against rapid oxidation, but must be removed carefully after the completion of each seam.

Gas welding is used only on 20-gage and lighter sheets. A small neutral to reducing flame is frequently used on a bare rod. The underside of the weld should be protected by a flux.

Spot and projection, seam, resistance or line welding can be easily applied to stainless steels which have good surface properties, low heat conductivity and melting point compared with mild steel.

Flash welding should be used with automatic control because the adjustments have to be precise.

Atomic-hydrogen welding is well suited to the working of stainless steel.

SOLDERING, BRAZING, RIVETING

Soft soldering serves only as a seal, not as a mechanical bond. The steel is cleaned well, special fluxes are applied and carefully removed after soldering.

Brazing: Hardenable-Cr stainless is brazed below 1,450 deg. F., soft ferritic below 1,300 deg. F. to pre-

vent grain growth. Stabilized austenitic stainless is also brazed at a low temperature because of the high coefficient of expansion. Silver brazing is preferred.

Riveting: Practically all low carbon stainless steels can be readily cold riveted. Free-machining variety may split unless the upset is modified. In hot riveting the hard-ferritic Cr steels will air-harden at 1,450 to 1,500 deg. F.

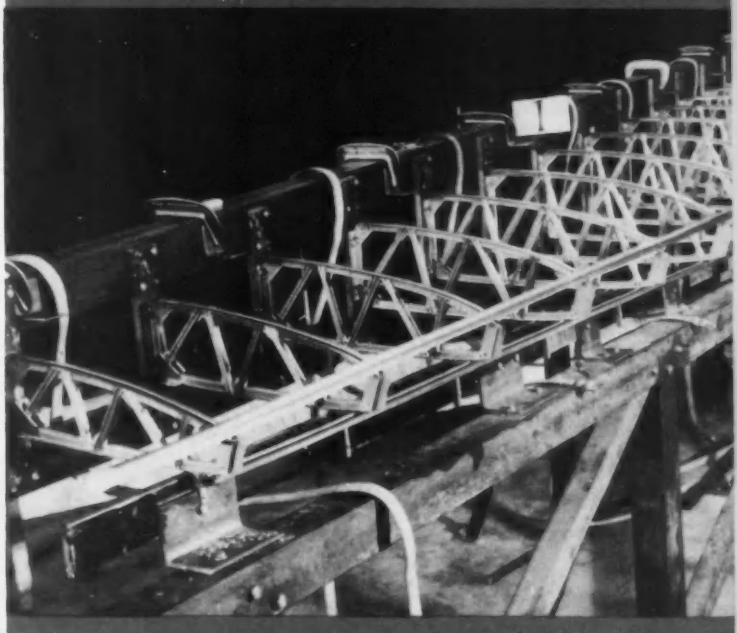
MACHINABILITY

In machining or forming, all high-chromium steels have a tendency to seize or stick to the tool when under pressure. During grinding the wheel becomes loaded, the work unduly hot and discoloration and distortion are likely unless pressure is maintained constantly.

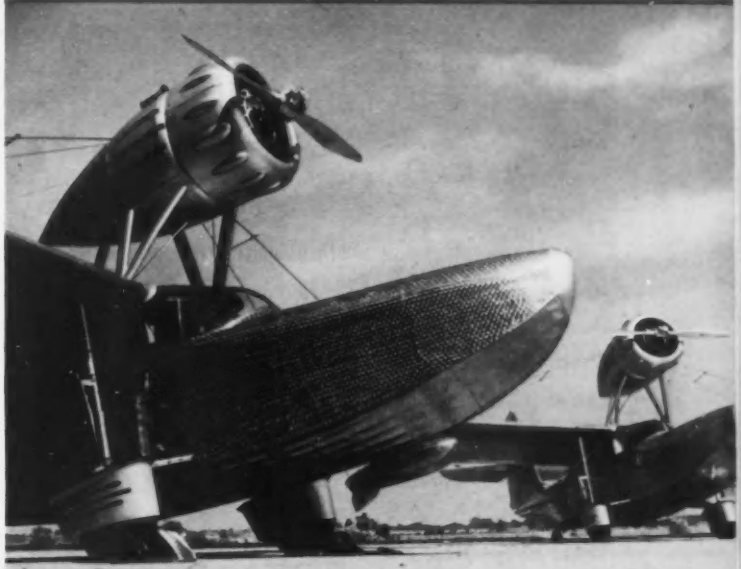
Austenitic steels work-harden under pressure which means that the next cut is rendered difficult, especially in fine cuts. To counter work-hardening effects only keen, high-speed tools are used with slow speeds and heavy, steady cuts. This rule applies to machining, as well as to sawing where a wavy, fine-tooth saw is used, and to drilling where a short-twist, sharp-edge drill is necessary. In shearing, straight-chromium stainless breaks after partial cutting, like mild steel, but auste-

Railroad streamlined passenger cars are fabricated by spot welding stainless-steel sheet to a structural frame also made of stainless steel.

Milk pumps resist corrosion and render longer sanitary service when they are made of stainless steel. Note design simplicity of this new type.



Trailing edge of airplane wing is typical of structural members fabricated from stainless steel to take advantage of favorable strength/weight ratio.



Low weight and high strength were important factors in the selection of stainless steel for construction of the Fleetwings Seabird before the war.

Vertical milk filter consisting of housing, displacement bell, screen and cloth filter is made of stainless steel for corrosion resistance and to facilitate cleaning.

Turntable in the packaging department of a penicillin plant is made entir of stainless steel to provide hygienic anti-corrosion conditions.

nitic Cr-Ni steels do not break and must be cut through completely. Power requirements are about twice those of mild steel and shear blades are much heavier.

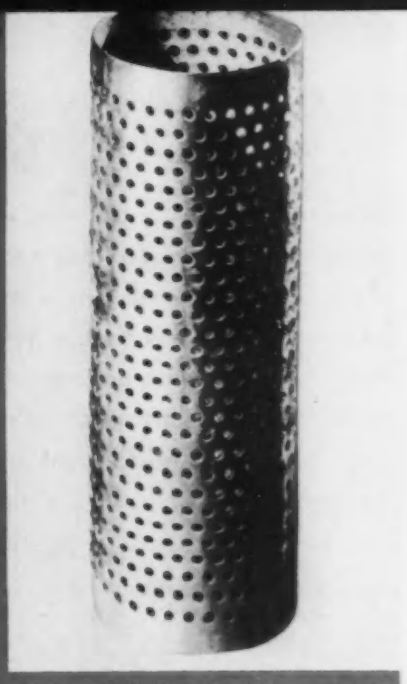
If machinability is the primary consideration in the fabrication of a stainless-steel part, free-machining grade is usually specified. This steel chips easily by virtue of the increased sulphur, phosphorus or selenium content. Compared with screw stock, it has a cutting rate of 80 to 100 percent, while ordinary stainless rates only 50 to 70 percent.

Stainless steels are about one-and-a-half times as strong as ordinary cold-rolled steels, but just about as ductile. Some users specify a high-nickel 18/8 with about 10 to 11 Ni for cold-working operations, such as drawing, forming or cold heading, because the ductility increases with the Ni/Cr ratio. While the plain Cr grades can be treated like cold-rolled steel, at least in light deformation, the pronounced work-hardening effect of 18/8, twice that of mild steel, combined with excellent elongation makes modifications necessary. In drawing and roll-forming, as in blanking, punching, pressing and spinning, stainless products require about twice the power, one-half the speed and much heavier equipment than mild-steel products of the same gage. However, a lighter-gage stainless can often be substituted because of the alloy steel's greater tensility.

Forging stainless presents certain peculiar difficulties. For instance 18/8 should be heated slowly up to 1,500 or 1,600 deg. F., then soaked at this temperature, and heated rapidly to 2,150 deg. F., but not beyond 2,200. Soaking above 1,700 deg. F. will cause pronounced grain growth. Rapid deformation at forging temperatures is safe only after the material flow has started. Generally little work is performed below 1,850, none below 1,700 deg. F. Time needed for heating is double that required for mild steel and the number of blows is about 25 percent greater. The surface finish must be good, seams or laps will not heal. Free-machining grades cannot be heavily forged.

The finishing operations of grinding, polishing and buffing are guided by the greater hardness and abrasion resistance of stainless steels, and the low thermal conductivity and high thermal expansion of austenitic stainless. Excellent surface finishes can be obtained when special techniques are employed. The various processes for the electropolishing of stainless steel are based on electrolytic anodic treatments which produce bright-luster finishes and increase the corrosion resistance of the material. Black-oxide finishes have been developed which are corrosion resistant and used where the shiny finish of stainless is not desired.

Housings for the 2,200-hp. engines of the B-29 Superfortress have many important parts made of stainless steel for strength with lightness and resistance to intense heat.



Perforated stainless tubes are used for catalysts by the processing industries.

CLADDING *Stainless* STEEL

CORROSION RESISTANCE as a surface effect can be insured by a variety of means. Possibilities lead from painting and chemical treatments, via galvanizing, plating, infusion processes (like Sherardizing, Calorizing, Siliconizing, Chromizing) to cladding. In cladding, a layer of stainless steel is bonded to a base metal which is usually mild steel. The quality of the bond determines the usefuness of the clad material. Production methods include casting, sandwiching, arc welding, spot or resistance welding, intermelting and fusion melting. The corrosion resistance of clad steel is that of the stainless facing, and the physical properties are governed by those of the base metal, of the stainless facing and their relative amounts. Steels are available as 20, 10 or even 5 percent clad, single or double faced with all the principal types of stainless steel. A good quality cladding will stand severe deformation without peeling or separating from the backing. It is claimed that clad steel is easier to fabricate than solid stainless; it can be flame-cut (solid stainless cannot be flame-cut without considerable trouble), welded, fabricated hot and cold, deep drawn and machined. Special techniques are employed in some of the various fabricating processes. The cost factor determines the use of clad steel in preference to solid stock. In applications where both sides of a thin sheet are exposed to corrosive attack, frequently solid stainless will be found more economical than a double-clad grade. On the basis of raw material economy and ideal design, clad steel would appear preferable, since it restricts a surface quality to the surface.

METAL SPRAYING of stainless steels has been applied both to render new parts of mild or alloy steel corrosion resistant, and to build-up worn or corroded parts, making them corrosion resistant.

Silver Meteor is one of many pre-war designs of stainless-steel streamliners which made railroad travel more comfortable and cleaner.

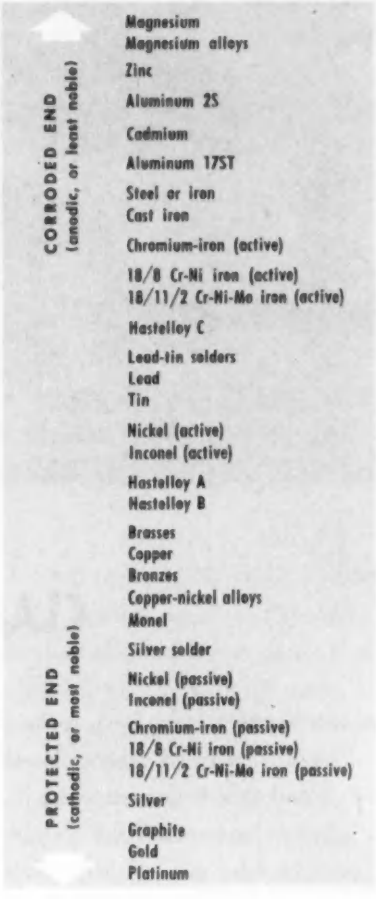
GALVANIC CORROSION

GALVANIC CORROSION results when two metals are in electrical contact and in the same corroding medium or electrolyte. An electric current is generated by the two metals in contact, in the same manner as in a carbon-zinc wet battery. The less noble metal is dissolved; the more noble metal is protected. The magnitude of the current is proportional to the increase in the rate of solution of the less noble metal above the normal rate of corrosion in the given medium.

As the behavior of metals and alloys varies in regard to galvanic corrosion, a series has been compiled on the basis of practical and experimental experience to show their relative tendency to form galvanic cells and to predict the probable direction of the galvanic effects. Both grouping and sequence of metals and alloys in this table are significant. Metals grouped together have no strong tendency to produce galvanic corrosion on each other, and may be used in contact with comparative safety. Coupling of two metals from different groups results in galvanic or accelerated corrosion of the one higher on the list. The farther apart the metals appear in the tabulation, the more pronounced will be the galvanic effect and the greater is the current generated.

Chromium-iron and chromium-nickel-iron alloys may change positions as indicated, depending on the oxidizing power and acidity of the corroding medium, or on the presence of activating ions, such as halides. The position occupied by the stainless steels may therefore be anywhere between the extremes shown in the table.

GALVANIC SERIES of METALS and ALLOYS



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Alloy Additions – Effect on 18/8 Stainless Steel, 1938, page 141

AMERICAN MACHINIST

Stainless Steel – Analysis, Properties and Recommended Practice for Machining, W. B. Brooks, 1941, page 643
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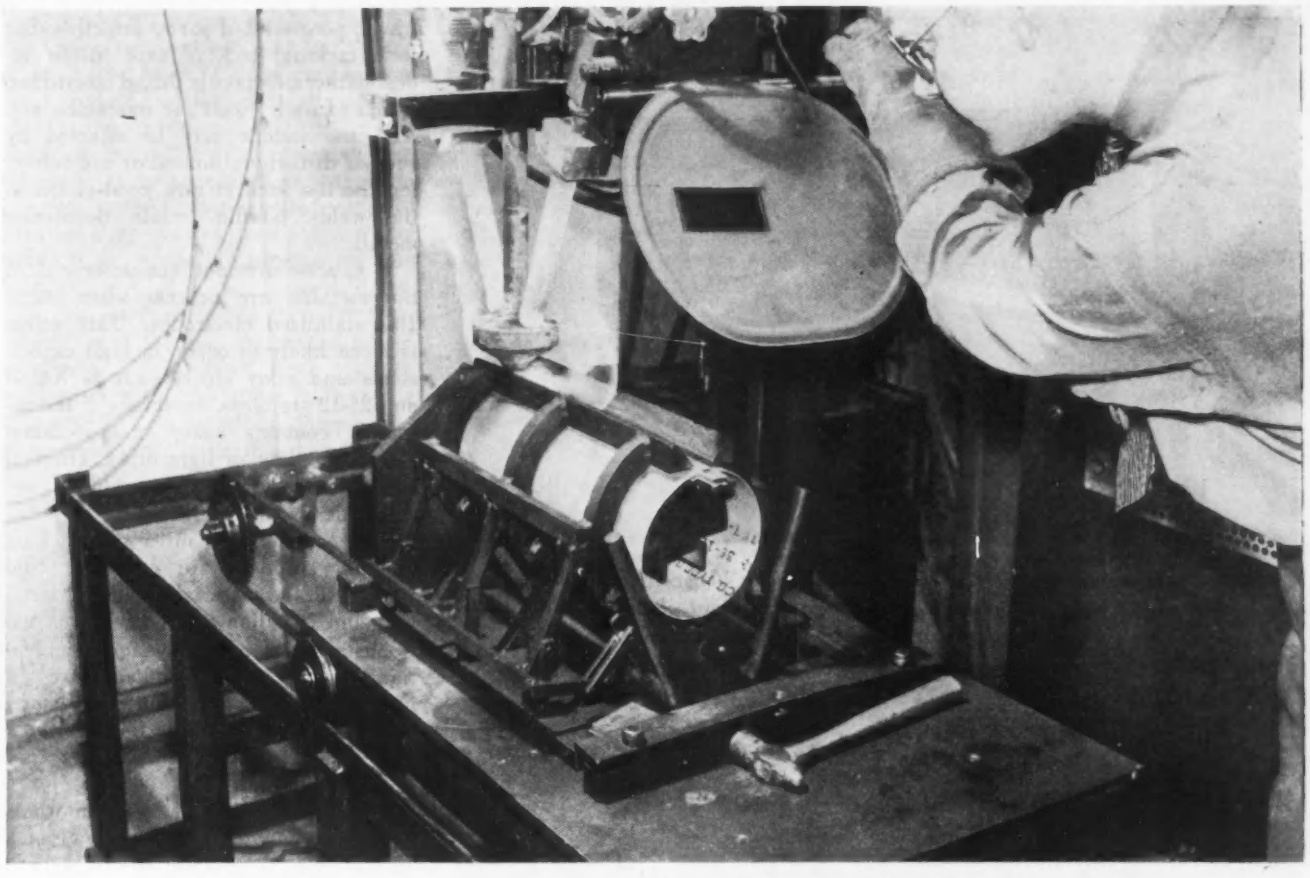


Fig. 1—One of the new automatic atomic hydrogen welding machines designed and built by Ryan Aeronautical Company to step up production rates and improve welded joints.

Causes and Prevention Of Defects in Welding

FREDERICK S. DEVER
Spot Welding Supervisor, Ryan Aeronautical Company

Common defects encountered in arc welding, gas welding, atomic hydrogen welding, and spot welding are described. Proper techniques and procedures to insure good welds are suggested to show that defective welding can be prevented.

THE CAUSES of defects in welding are usually preventable faults in technique or procedure. For this reason welded fabrication should not be rejected on the drafting board any more than any other fabrication method when done by competent fabricators, experienced or high-grade workmen. Ryan Aeronautical Company has classified the defects that are most likely to occur in welding and indicated how they can be identified and prevented. While this knowledge is most valuable to welders, welding department foremen and inspectors, design engineers find that familiarity with these production problems gives assurance when any welded construction is desired, that satisfactory welded joints can be made if proper technique is applied. Recent developments in welding equipment also should give greater assurance of satisfactory welded joints, particularly in resistance welding where electronic or other automatic means of controlling welding heat and timing are used. It must be recognized in using such equipment, however, that these refinements in machines necessitate operator skill comparable to that required for fine machine tools.

The defects encountered in arc welding, gas welding, spot welding, and special welding methods vary and their correction involves different procedures. In arc welding lap, fillet and butt joints, the common defects are likely to be caused by poorly fitting the parts together, improper tack welding, lack of proper technique and application, or any combination of these. Metallic arc welding defects have been classified in 10 general groups.

1. "Burn through," usually associated with lap welding, is defined as penetration exceeding 100 percent. This is sometimes not too serious. In 18-8 stainless steels, however, the oxidation

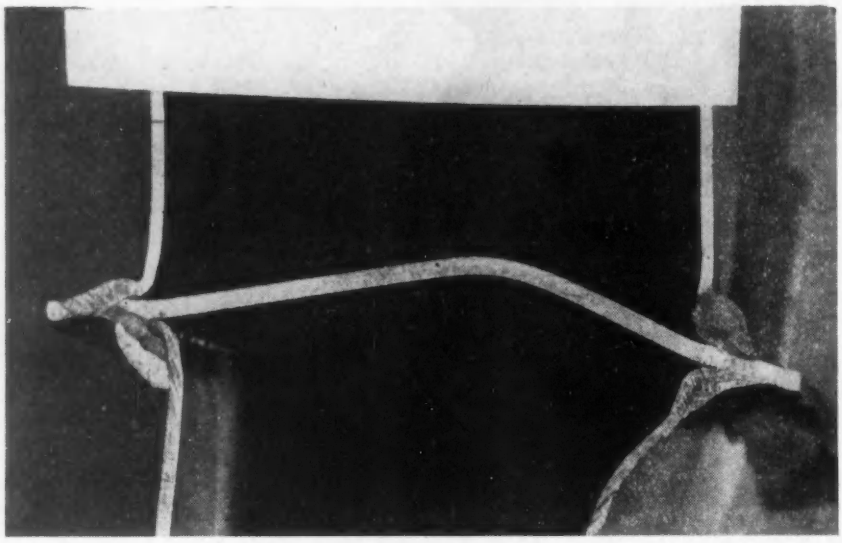


Fig. 2—Two-pass arc weld showing poor fusion between the weld and parent metal because flux left by first pass was not cleanly removed.

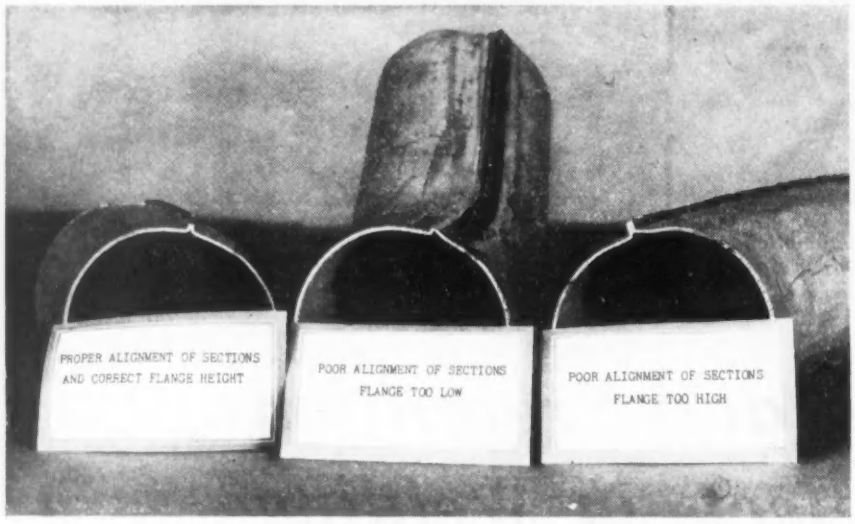


Fig. 3—Proper and improper alignment of sections for flanged seam type joints before tack welding.

produced lowers heat and corrosion resistance of the metal, which is one reason for identifying "burn through" as a defect. There may be one or several causes for this defect.

A variation of welding speed to compensate for excessive gaps in poorly fitted parts will cause burn-through because the heat input is excessive in these areas where a large amount of weld metal is required to fill the gaps in the joint.

If voltage and amperage are too high for the metal thickness being welded, the resulting excessive heat will cause burn-through. If the rate of travel or welding speed is too slow or erratic (fast and slow), burn-through may result. The angle at which the electrode is held may contribute in causing this defect. In tacking, the use of extreme heat setting may result in small burn-through areas or large tacks, which the welder must fuse when completing the weld.

2. Overlap, often called a "cold weld," is a defect characterized by lack of fusion between parent metal and weld metal. It is usually small in area. Overlaps may be caused by too low voltage or amperage, too fast travel of electrode, flux on tack welds, excessive scale on parts, flux from electrodes "getting ahead" of weld metal deposit, peculiar flux action caused by incorrect angle of electrode, or by large "cold" tacks that do not fuse with the finish weld.

3. Skips or omissions refer to uncompleted welds at certain points. Improper positioning of a part to be welded can cause this defect, especially if the welder does not have a complete view of the weld area. Other causes are flux from tacks, or flux "balling up" during welding, erratic speed of electrode travel, poorly fitted parts, defective spot weld tacking, lack of care inside 90-deg. corners, or poorly fluxed electrodes, which cause a "wild" or unstablbe arc. Also the welder may be affected by sudden disturbing noises, or his helmet lens be too dark to give good vision of the weld "puddle" while depositing metal.

4. Cracks are not characteristic of the metallic arc process when using 18-8 stabilized electrodes. This defect is more likely to occur in high carbon steels and alloy steels such as X4130 and 25-12 stainless, especially if the assembly contains heavy cross-sectional fittings or plate, or light tubes. Thermal stresses set up during welding are sufficient to cause cracks.

The commonest causes of cracking in 18-8 stainless are excessive cold working of the material, including forming and bending after welding, extremes in light to heavy gage combinations, which cause shrinkage stresses, incorrect welding procedure, and shear or tension loadings while the weld area is at 1,200 to 1,600 deg. F., the "hot short" temperature.

5. An undercut is a defect in which the weld metal deposit leaves a notch on one or both sides of the weld bead and is insufficient to fill the crater in the joint. Concentration of stresses in these notches is, of course, serious.

There are four leading causes of undercuts. Excessive heat from too high amperage and voltage makes parent metal and weld metal too "fluid," causing them to sag under the influence of gravity. If the rate of electrode travel is too fast, the weld metal is insufficient to fill the crater left by the heat of the arc. These two conditions should be coordinated to give adequate penetration and a well-rounded weld bead. Concentration of heat on one plate, resulting from electrode angle, causes undercut. Since the weld metal is fluid while being deposited, it will flow away from one plate if the position of the work permits, and cause an undercut.

6. Flux pockets and inclusions are defects that occur when the material is not clean, as in Fig. 2, and when improper technique is used. Flux and oxides are either included in the weld metal or replace weld metal in some areas. Designs that have "closed angles" encourage flux pockets but they can be largely avoided by proper welding position. Too low welding heat prevents the flux from becoming fluid enough to float on the surface of the weld metal. Large mis-shapen tacks may trap flux if insufficient care is taken to prevent. When an electrode directs the arc ahead of the weld deposit flux entrapment is encouraged.

7. Poor starts and endings on welds

are common, especially on short welds 1 or 2 in. long. Characteristics are large deposits at the start and insufficient weld metal at the end. This defect is the result of carelessness usually and can be prevented by correcting the heat range, using a voltage control rheostat for starting and ending the weld, and properly positioning the work.

8. Excessive weld deposits result from several conditions or combinations of conditions: Insufficient heat to fuse weld to parent metal, attempts to repair a "burned" hole or other defects, improper starting, large mis-shapen tack welds, failure to clean material, excessive weaving of electrode, and skipping back to cover an omission.

9. Shallow weld deposits, when insufficient weld metal is deposited, do not always produce an undercut but leave the weld with insufficient strength because the cross-sectional area is too small. If the heat range is high the rate of electrode travel must be fast enough to prevent excessive penetration, leaving insufficient weld metal. Too small diameter electrodes acts similarly. These two factors must be coordinated.

10. The use of a standard proved weld procedure cannot be over-emphasized if uniform consistent welding is desired.

Gas Welding Defects

The major uses of oxy-acetylene welding at Ryan Aeronautical Company are "gas tacking" and fusion welding of flanged seam type joints, as shown in Fig. 3. Defects that are described are based on these applications. A combination of conditions may cause defects. Four key points of welding are uniformity in height of weld, width of weld, speed, and amount of filler rod. Gas welding defects are classified into 10 general groups.

1. Inconsistency, a defect characterized by a varied height and width of weld, usually results from poorly fitted parts, as in Fig. 3, incorrect rate of welding, unevenly trimmed flanges, improperly positioned parts, part contour not property aligned, and poorly tacked parts.

2. Excessive penetration is usually caused by too high a flange or addition of filler rod to a flange of proper height. Excessive heat input requiring filler rod to bring weld height to proper level also contributes to this defect. Too slow welding speed, excessive weld width, and striving to produce a "flat" bead on the weld surface are also causes.

3. Insufficient penetration, characterized by little or no reinforcing bead on the under side of the weld, is usually caused by low heat input, too great weld height, too fast weld speed, improperly applied flux, torch at too low an angle or improper weld motion, and dirty scaly metal.

4. Undercuts are caused by too high heat input, too slow welding speed, insufficient flange or filler rod, too wide weld, and poor welding technique. This defect parallels excessive penetration since they are caused by the same conditions.

5. Porosity, illustrated in Fig. 4, makes a weld weak and brittle. Some 18-8 steels, particularly those stabilized by titanium, are susceptible. A smaller flame and tip and slower rate of travel are advantageous. Excessive puddling induces porosity. Mild steels are usually free from this defect.

6. Cracks may be caused by stresses set up by welding, as in Fig. 5, or by cold work and forming after welding. Since oxy-acetylene affects a larger area than arc or atomic hydrogen welding because it is a slower welding method, thermal stresses are greater. Parts held rigid by jigs and fixtures are more likely to crack upon cooling. Post-heating in the area surrounding tack welds prevents cracking. Stabilized 18-8 steels are not as prone to crack as high alloy steels of the X4130 and 4140 groups. Insistence that parts be correctly and accurately fitted before welding will reduce the amount of cold working required, thus decreasing the number of cracks produced.

7. Inclusions are not as common in oxy-acetylene welding as in arc welding. Dirty, scaly parts, the presence of excessive oxygen in the flame and an oxydized weld rod, fluxed welding rod, and flux leaking into poorly fitted parts all produce this defect.

8. Excessive weld width results only from poor welding technique and poorly fitted parts.

9. Poor starts and endings are usually characterized by the burning away of parent metal on endings and large blobs of weld metal at the start and are usually the result of inexperience or use of incorrect weld procedure.

10. "Mushroom" penetration, where weld metal fails to bond at the edges, is not too common. The usual cause is an unsuitable welding flux.

Atomic Hydrogen Welding Defects

In general, atomic hydrogen welds have the same defects as oxy-acetylene welds, and for the same reasons. Since heat concentration is greater, the operator must pay closer attention and some

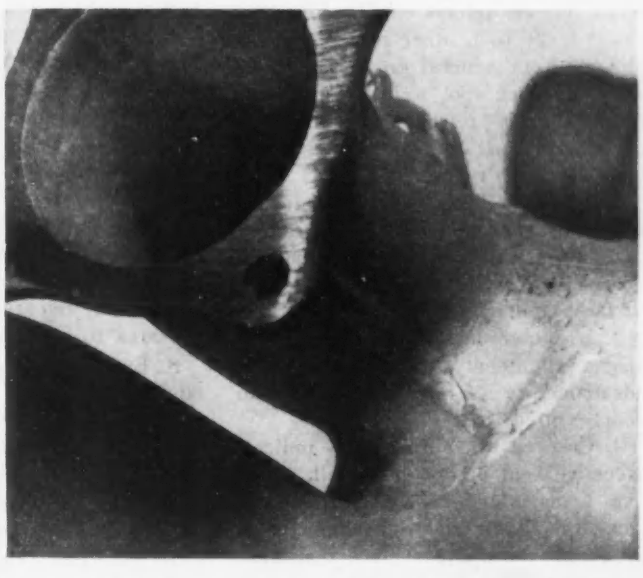


Fig. 4 (Left)—Blow holes were caused by errors in timing this oxy-acetylene welded seam. Fig. 5 (Right)—Crack in weld metal deposited by gas welding was caused by improper flame adjustment, which deposited carbon in the weld.

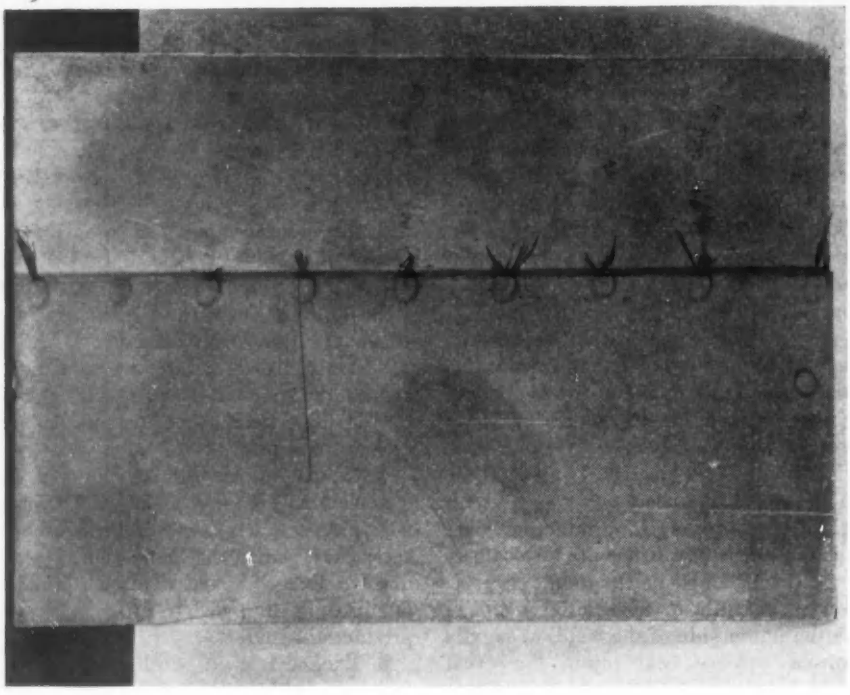


Fig. 6—Spot welds are poorly placed in this stainless steel piece because of insufficient edge distance. This member has far less than required strength.

faults in technique are more noticeable in this process. The rate of welding is faster than gas welding and errors can occur faster.

In addition to the normal defects noted in gas welding, a defect known as "worm holing" may occur. This is caused by trapping of gases in the weld metal and can be prevented by reducing heat input and a slow rate of welding.

Spot Welding Defects

Defects are allowed by most spot welding specifications but are limited to 5 percent for structural and 10 percent for non-structural spot welds. Since not all defects can be found by visual inspection, other means are employed. Four general groups of causes are: improper spot welder set-up, improper surface preparation, poorly fitted parts, and operator carelessness. Defects are of 16 types.

1. Excessive indentation indicates too small electrode diameter or tip radius, excessive pressure or heat, or a combination of these factors with poorly cleaned surfaces and poorly fitted parts.

2. Irregular shaped spots indicate improper alignment and contour of tips, unsatisfactory surface preparation, or poorly fitted parts.

3. Cracked or "burnt" spots indicate excessive heat or current dwell, excessive penetration, poorly cleaned surfaces, unsuitable electrode diameter or tip radius, excessive surface resistance caused by other than surface preparation, poorly fitted parts, internal or external splash, which are defined in 6 and 7, or incorrect pressure.

4. Spotwelds too close to edge, as in Fig. 6, may result from lack of sufficient edge distance or operator carelessness.

5. Low shear strength, barring defective welds, results from insufficient cross-sectional weld area. This indicates either low penetration (less than 20 percent of sheet thickness) or merely too small diameter weld, which can be corrected by adjustment of machine variables. In rare instances insufficient pressure may be the cause. Inconsistent shear strength creates a condition where weakening and failure of weaker spot welds throw overloads on adjacent spot welds, thus causing progressive failures.

6. Surface or external splash is displaced or extruded parent metal, which weakens the spot weld. A number of conditions or combinations of incorrect conditions cause overheating, which makes the metal plastic through its entire thickness.

7. Internal splash occurs at the bond as a result of a number of preventable and incorrect conditions that prevent the normal retention of weld metal in the area to be bonded.

8. Excessive penetration (more than 80 percent of sheet thickness) weakens joints because of the lack of wrought material to carry the stresses across and around the cast area of the spot weld. Rapid failure under vibration and fatigue in tension loading are probable. Extreme stress concentration is caused around a weld spot with excessive penetration. Excessive heat or weld time are the usual causes. Localization of heat by too small electrode tip may be the cause.

9. Excessive sheet separation is usually encountered in poorly fitted parts. The spot weld becomes a column joining the sheets. This type of spot is not acceptable. Correctly fitted assemblies eliminate this defect.

10. Insufficient penetration is indicated by too low shear strength. Spot welds of correct diameter and shape usually have enough shear strength if penetration exceeds 20 percent of sheet thickness. Increase in heat range or weld time or both is the solution.

11. Internal cracks, either parallel or perpendicular to the sheet, may be caused by too large electrode diameter, which produces a large cast structure and causes strains on cooling. Too short a hold time may release stresses before the plastic metal is strong enough to resist them.

12. Porosity is usually found near the center of the cast area of the spot weld and is indicative of poor welding technique. It can be corrected by proper surface preparation, machine settings, pressure, heat range and weld time.

13. Weld inclusions are associated with poor surface preparation or lack of cleanliness.

14. Surface inclusions are also associated with poor surface preparation and dirty, misaligned and overheated electrodes. Excessive pressure may also contribute to this defect.

15. Incorrect spacing must be guarded against. The pattern of spot welds should be designed to give certain joint efficiencies. If this pattern spacing is not maintained, joint strength is reduced. Care in maintaining proper spacing, as given by design, cannot be over-emphasized.

16. Poor fit of parts results in spot welds being left in tension, thus having from 0 to 25 percent of required shear strength. Good design for spot welds prohibits tension loading. Poor fits may also cause excessive sheet separation, internal splash, excessive indentation, distortion of the completed unit, inconsistent welds, and poor appearance.

Familiarity with welding defects and their causes can be used to advantage on the drafting board where parts can be designed to minimize some of the factors that are likely to cause difficulty in welding. Designers can indicate by dimensioning or notes the various requirements respecting welding quality, cleaning of surfaces, use of jigs or fixtures, penetration limits, spacing of spot welds, or other conditions. Welding techniques have been improved rapidly for war production and the widely increased knowledge will insure expanded usefulness for welding.

Press Forming Possibilities Of Heavy Sheet and Plate

Design possibilities in stamping, forming and drawing heavy metal sheet and plate in presses are discussed. Cold work in thicknesses up to ¾ in. and hot work up to 3½ in. are illustrated in various sizes and shapes of heavy wall parts.

EXPERIENCE gained during the war in the production of parts stamped, formed, or drawn cold out of heavy sheet and plate up to ¾ in. thick, indicate the possibility of many further applications for this type of fabrication. Millions of shell cases have been made from steel disks about ⅜ in. thick. Mortar shells as large as 60 mm. have been drawn cold from 4½ in. diameter blanks 0.670 in. thick. Further progress has been made in the pressing of heavy complicated shapes such as rear axle housings for motor cars, trucks and buses. Advances have also been made in the manufacture of large and still heavier gage hot pressings, such as ellipsoidal heads for cylindrical pressure vessels, mainly in greater perfection of methods and wider range of shapes.

Preferred steels for heavy press operations are the same as those for light work, namely low carbon — 0.08 to 0.12 percent. Steel with 0.20 percent or more carbon is difficult to form, the carbon seeming to cause more breaking because of greater hardness and brittleness. The upper limit for cold forming is about 0.30 carbon. Cold rolled steel is better where smooth finishes are required, and for painting or other reasons. However, if annealing is required between forming operations, the finish would be impaired so that little would be gained. Cold rolled strip steel has better drawing characteristics, stands more drawing operations and has a closer gage accuracy but is not generally available in thicknesses greater than ⅛ in. Greater thicknesses do not have the surface quality of thinner gages.

High-strength steels can be used but they have some limitations that might be attributed to their lower elongation. Generous bending radii must be allowed on these steels. Stainless steels are, in general, rather expensive in heavy material and therefore not used unless required for heat or corrosion resistance. The 18-8 stainless has excellent drawing properties. A much greater reduction in the blank can be secured with stainless than with ordinary steel but its work hardens faster than low carbon steel. Stainless clad steels have been formed and drawn to some extent in the heavy weights and their drawing qualities have been found to be approximately those of the base metal.

Other metals have also been employed for heavy work. Aluminum is usually satisfactory. The harder alloys are more difficult to work but a bowl of 10 in. depth and 8½ in. dia. has been made of 52S in ⅝ in. stock, which was reduced to ⅛ in. Propeller domes 11⅝ in. in dia. and 13¾ in. deep have been drawn from 0.45-in. stock of 61S aluminum.

Little has been done with heavy magnesium. Drawing of propeller domes duplicating those of aluminum, from ½ in. magnesium is recent interesting development.

Brass is an excellent drawing material, and is particularly good when ironing operations are required. In cartridge case production, a disk of brass ½ in. thick is drawn in four operations to a thickness of 0.04 at the open end.

Copper is a good drawing material but is seldom used in the heavy plate thicknesses.

Press Operations

Blanking operations in heavy materials are limited in size and thickness by the size of presses available. If requirements are beyond press capacity, blanks can usually be sheared or flame cut to shape. Material ¾ to ⅞ in. thick is about as heavy as practical for blanking in the usual press equipment.

Drawing operations in low carbon steel can produce shapes ranging from round to rectangular cross-section. Stock ¼ in. thick and 60 in. in diameter can be drawn easily to a flange drum 6 in. deep, or the shell could have been made much smaller in diameter and deeper if desired. Rectangular shapes are more difficult and are more limited by press capacity as to blank size and depth of draw, but are feasible. Deepest draws require hydraulic presses. The problem of bulging and buckling in the flat sides must be taken into consideration. Wrinkling and distortion are not as important or troublesome in heavy gage, which simplifies designing problems for any shape.

While the drawing of stainless steel requires about twice the power used in drawing low carbon steel, it is possible to give a more severe draw in the first operation.

Commercially pure aluminum and 3S draw readily and do not work harden as fast as steel. Several drawing operations can be made without annealing. Tool upkeep is generally lower but dies must have a fine finish for best results. Several of the higher strength aluminum alloys are also used in making strong light-weight stampings.

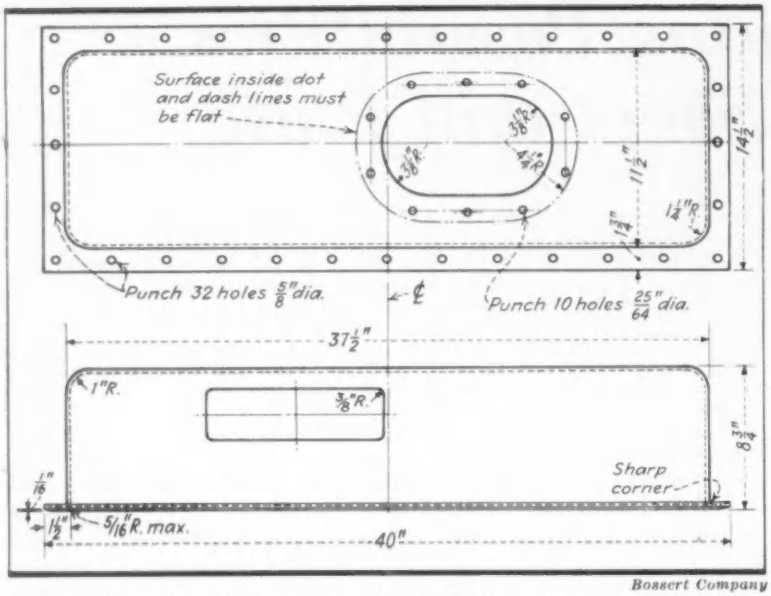
Big reductions can be made in drawing operations on brass, and tool upkeep is low. It work hardens, however, and requires annealing.

In general, a round blank can be drawn in one operation to a cup approximately 50 percent the diameter of the original blank. If additional operations are to be performed, the first reduction should be limited to 40 to 45 percent. Depths of cups or tubes can be drawn to six to eight times diameter. Beyond this point, stampings are competing with seamless tubing with ends closed by spinning, welding or brazing.

Forming operations in heavy material is limited largely by allowable radii. Soft steels, low alloy aluminum and brass form easiest and have fewer limitations in shape. Commercial low alloy steels have more limitations, requiring more power to form and larger forming radii. If sharp radii are required, hot operations and heat-treatment are necessary to develop full strength.

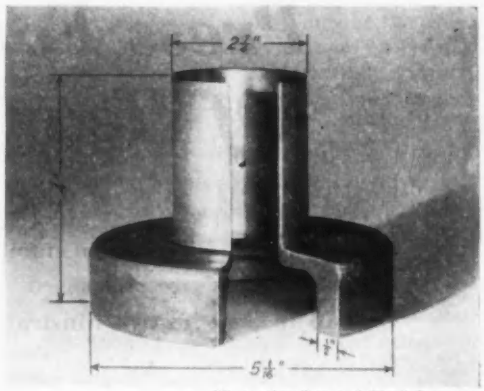
Design Features

Radii are one of the most important considerations in designing parts for drawing operations and somewhat less important in forming operations. Sharp radii can always be secured if essential by additional operations but at increased expense. For simple bending operations the inside radius should be at least the thickness of the stock. On



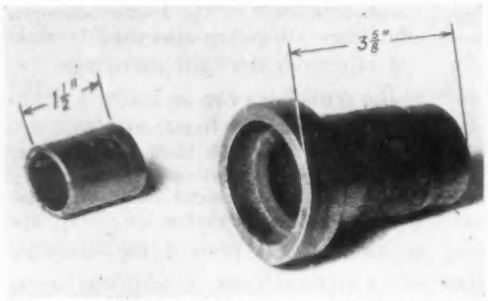
Bossert Company

A rectangular deep drawn part, such as this cover for a large gas meter in ¼ in. hot-rolled steel, is an excellent indication of cold drawing possibilities in heavy sheet steel. Plus or minus 1/32 in. tolerances are held on most of the dimensions of this cover.



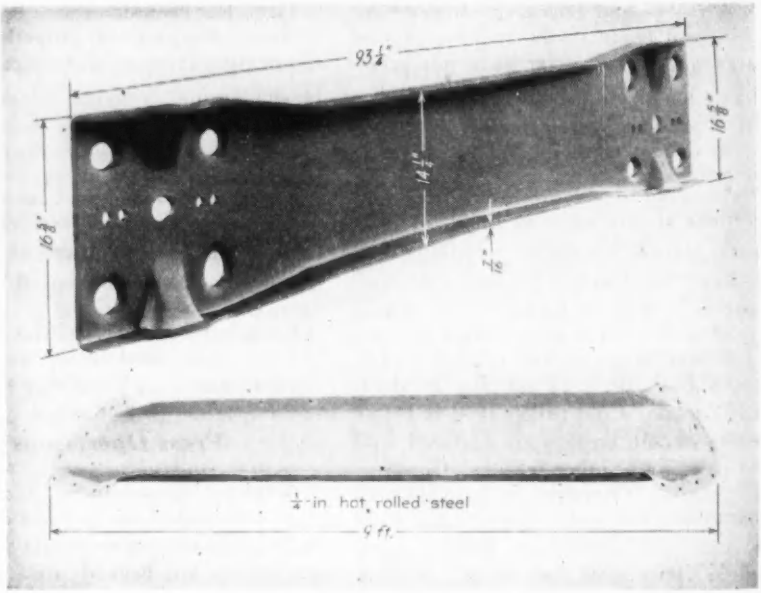
Worcester Pressed Steel Company

Extremely close dimensional tolerances are practical possibilities in pressing and drawing heavy stock for gear blanks, sleeve bearings, and similar parts. Blank for this part is low carbon steel ½ in. thick, 6¼ in. in dia. Tolerances of ±0.001 in. are held on both inside and outside diameters of the barrel, which will be given a high polish finish. Cost was reduced to less than ¾ that of machined tubing although several press operations were required.



Acklin Stamping Company and Bossert Company

(Left) These tappets for a 200-hp. marine engine are simple in design but the practically square corner at the bottom of the cup required ingenuity. This is achieved by lathe trimming the open end and then packing the metal back by striking the open end while confining the ⅛-in. walls, thus causing metal flow into the corner. Cost of 6 cents per piece produced large savings. (Right) One-pound fuze case drawn from a 2¾ lb. blank of ¼ in. sheet steel was formerly machined from a 6½ lb. piece of bar stock. Severe working made three anneals necessary between drawing operations. Several machine operations were required to finish this case.

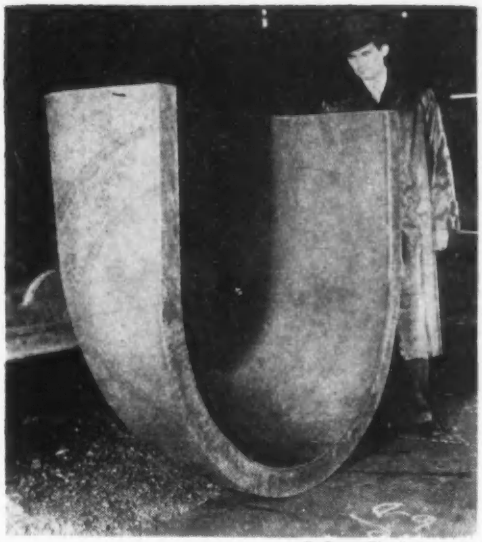


All holes on these railroad car parts fabricated by Parish Pressed Steel Company, are punched at once on a press in the flat before the forming operation. The 93¼ in. spring plank for a hopper car is made of 7/16 in. stock. The 9 ft. hood sheet is formed to a depth of 15 in. and width of 13 in. in one operation.

1/8 in. to 1/16 in. stock sharp corners such as 1/16 in. radius, can be obtained if using low carbon steel, commercially pure aluminum or 3S aluminum, but not in the harder and higher strength low alloy steels. In these the radii should be as much as four times thickness, particularly in heavier gage material.

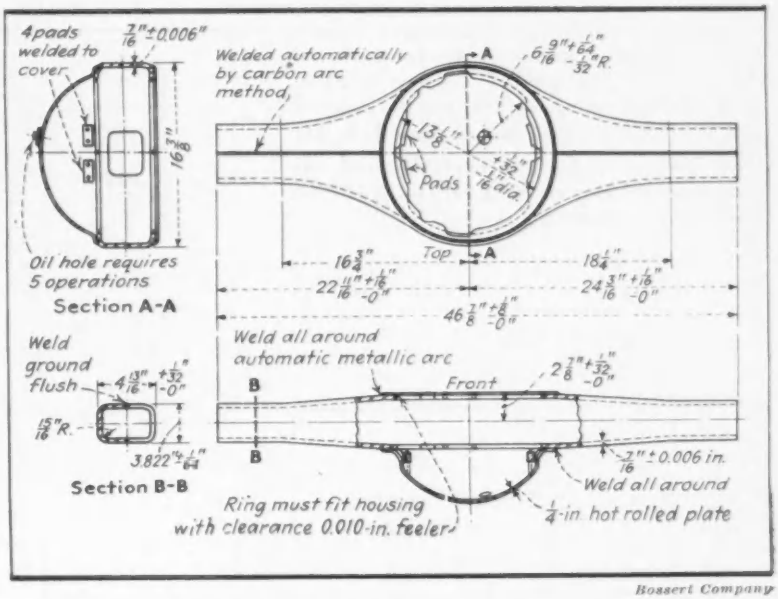
Somewhat greater radii should be used in drawing operations than in simple bending or forming operations. For rectangular shells, the vertical corner radii should be ¼ to ⅙ the depth of the shell. Good practice for the radius at the bottom of the drawn shell is at least two to three times the thickness of the stock. Subsequent operations are often feasible to sharpen corners.

In the drawing of conventional shells, if the radius at the bottom of the first draw is five times the thickness of the material it is possible to maintain a uniform thickness of wall and bottom and the material will not be stretched badly. Brake drums ⅜ in. thick have been made with ¼ in. radii at the bottom but this thins out the metal at that



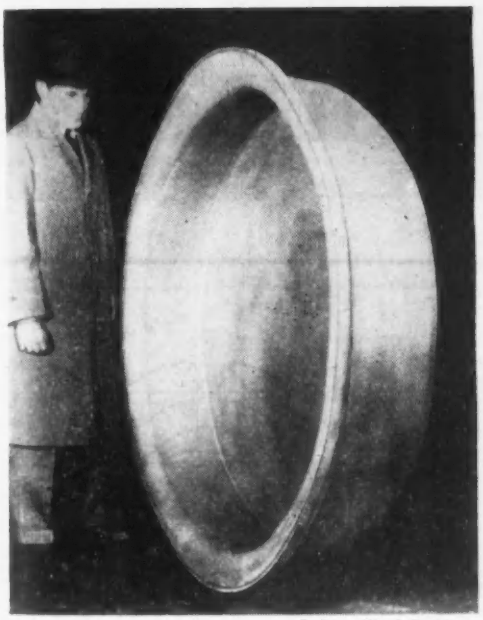
Lukens Steel Company

Most press forming is done cold but plate more than 13/16 in. thick is more easily worked hot. Steel plate as thick as 3½ in. has been pressed by Lukens Steel Company. This 4,300-lb. section is 22¾ in. deep. Radii of curvature are 7½, 17 and 26 inches.



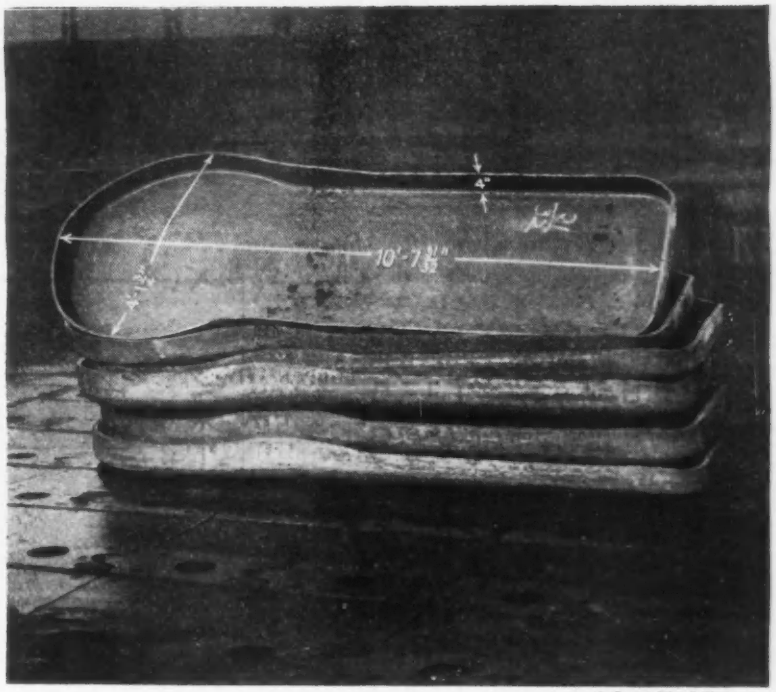
Bossert Company

Pressed rear axle housings for trucks continue to be produced in large numbers for welded assembly. Housings are made of 7/16-in. by 14¼ by 90 in. strip in 0.18 to 0.23 carbon hot-rolled steel with only two forming operations. Bull ring is 7/32-in. plate rolled to circular shape.



Lukens Steel Company

This 2,000-lb., 64½-in. dia. brake drum for oil well equipment is pressed in 1½-in. steel plate to a depth of 11⅞ in. overall, with ¾-in. (½t) inside corner radius.



Lukens Steel Company

Flanges of these boiler combustion chamber heads are hot pressed in 13/16-in. steel plate thus requiring less pressure than cold work.

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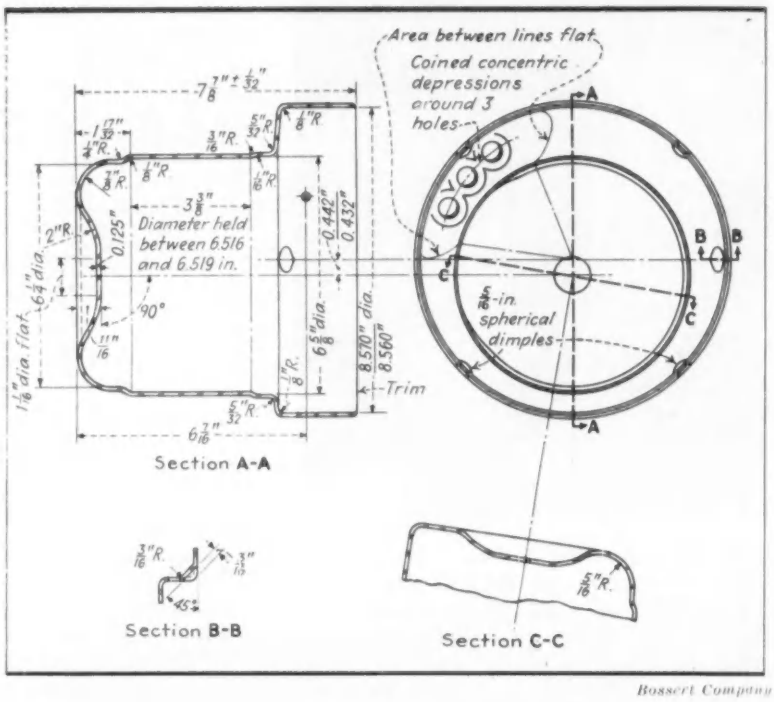
point. If sharp radii are required it is better for the material if it be given another draw. Radii can be sharpened to less than one times thickness by redrawing. If the radius is made too small in the first operation the bottom will be pushed out.

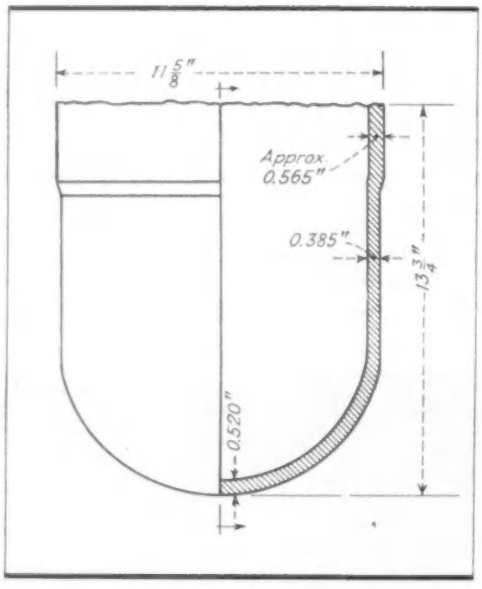
In piercing holes experience indicates that the diameter should not be less than stock thickness, otherwise there will be excessive breakage of punches. While holes of smaller diameter can be punched, the cost is increased. Diameter tolerance can be held to ±0.002 in. in ⅛ to ¼ in. stock. On heavy stock, holes requiring smooth finish and close size tolerances are punched slightly undersize and finished by broaching, shaving or reaming, as required.

Designers can do much to ease the stamper's problems when considering substitution of stampings for castings, by reconsidering the design from the functional requirements and dimensional limitations rather than asking for a duplication of the casting, particularly where the casting is complicated by

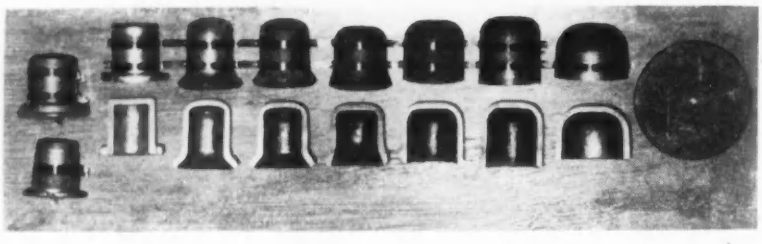
(Right) Possibilities of design and production of complex shapes in drawn shells are shown by this housing of hot-rolled 0.125-in. steel. Notable complications are the reduced and eccentric bottom, which must have the same wall thickness throughout, and the diametral tolerances of 6.516 to 6.519 in. for a press fit into the case.



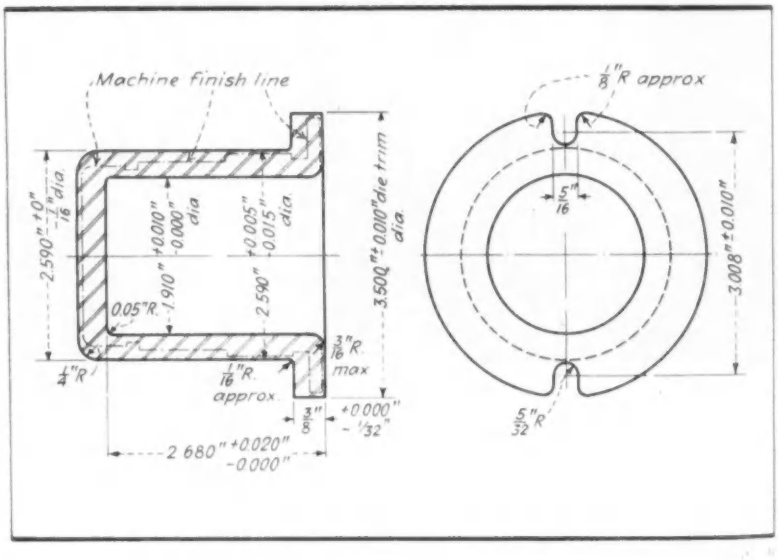
Bossert Company



Thousands of aluminum propeller domes, such as this one shown after the third press operation, have been pressed in ½ in. 61-S stock. Worcester Pressed Steel Company is now able to draw the same domes in ½ in. magnesium alloy at elevated temperature. Two ring-type gas burners surround the work, which is done on the same machines as aluminum domes.



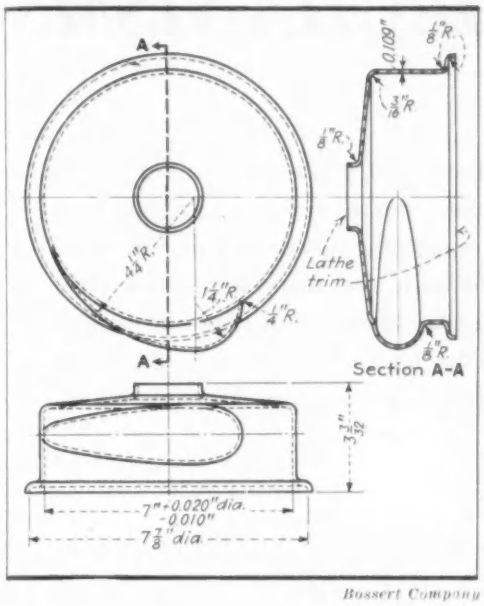
(Right) Flanged cup drawn from a 11/32-in. hot-rolled 1020 SAE steel blank 6 5/16 in. in diameter requires five anneals between severe drawing and reducing operations. Sharp fillets inside and under the flange are the most difficult details in production.



several different thicknesses of section and by bosses. Costs mount rapidly if small bosses, stiffeners, and other details have to be welded on the part and when sharp corners are required. Even such considerations as utilization of cutouts should be kept in mind for economy of production in heavy gage material. They can often be used for smaller stampings, such as nuts, washers, special angular parts, and the like.

Desirable dimensional tolerance for fairly large stampings in heavy stock is ±2½ in. on drawn diameters. At added cost, however, ±0.0003 in. can be held on diameters and generally on thickness of shells. Still greater accuracy can be produced by coining or sizing operations.

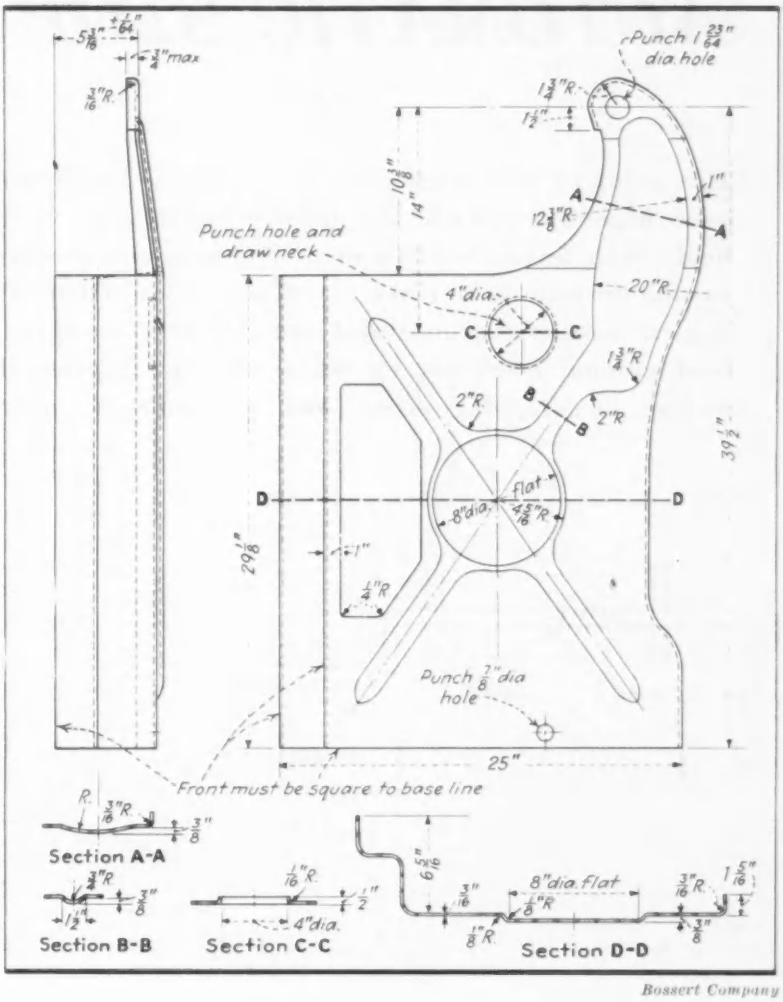
Since stamping operations have never been standardized or classified, their production is still more of an art than a science and dependent upon the skill



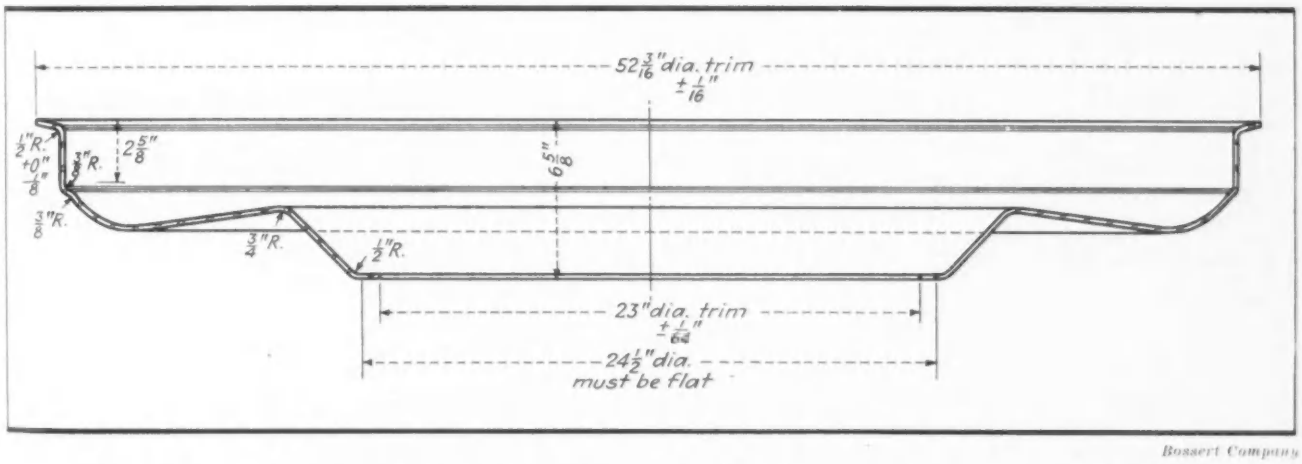
Bossert Company

(Above) Case drawn from cold rolled strip 18-8 stainless steel of 0.109 in. thick. The bulge in the side is the feature of this part.

(Right) Machine side frame stamped in 3/16 in. hot-rolled sheet steel shows the complex forms that can be pressed into heavy gage material. Radii of 1/3 t and 2/3 t are produced on the flange of the drawn neck and in section DD.



Bossert Company



Bossert Company

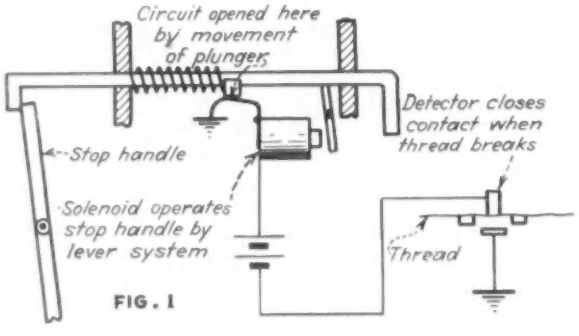
Drum head of 1/4 in. hot-rolled 0.20 to 0.30 carbon steel. Close dimensional tolerances are required on outside diameter and on flatness on the bottom. Various radii of 1t or more show good design practice.

of engineering specialists and press men. Many design problems in stamping production are worked out in the shop. Since specialists in stamping designs must often work with the shop in developing economical designs it must be obvious that when stampings are to be purchased best results in adapting stampings to equipment in general can be obtained only by cooperation with stamping specialists, perhaps with two or more firms because of possible differences in skills, specializations and available press equipment. These examples of press formed and drawn parts show new application possibilities.

Acknowledgements are accorded to Pressed Metal Institute, The Bossert Company, Inc., Lukens Steel Company, Worcester Pressed Steel Company, Parish Pressed Steel Company, and Acklin Stamping Company.

AUTOMATIC STOP MECHANISMS

This group of stop mechanisms is a continuation of those illustrated in the September, 1944 issue, pages 612 and 613 and includes further types and applications to machines in different fields. Such devices, which prevent automatic machines from damaging themselves or the work passing through them, make use of mechanical, electrical, hydraulic and pneumatic principles. Typical mechanisms illustrated prevent excess speed, misweaving, jamming of toggle press and food canning machines, operation of printing press when the paper web breaks, improper feeding of wrapping paper, and uncoordinated operation of a glass making machine.


Circuit opened here by movement of plunger
Detector closes contact when thread breaks
Stop handle
Solenoid operates stop handle by lever system
Thread
FIG. 1

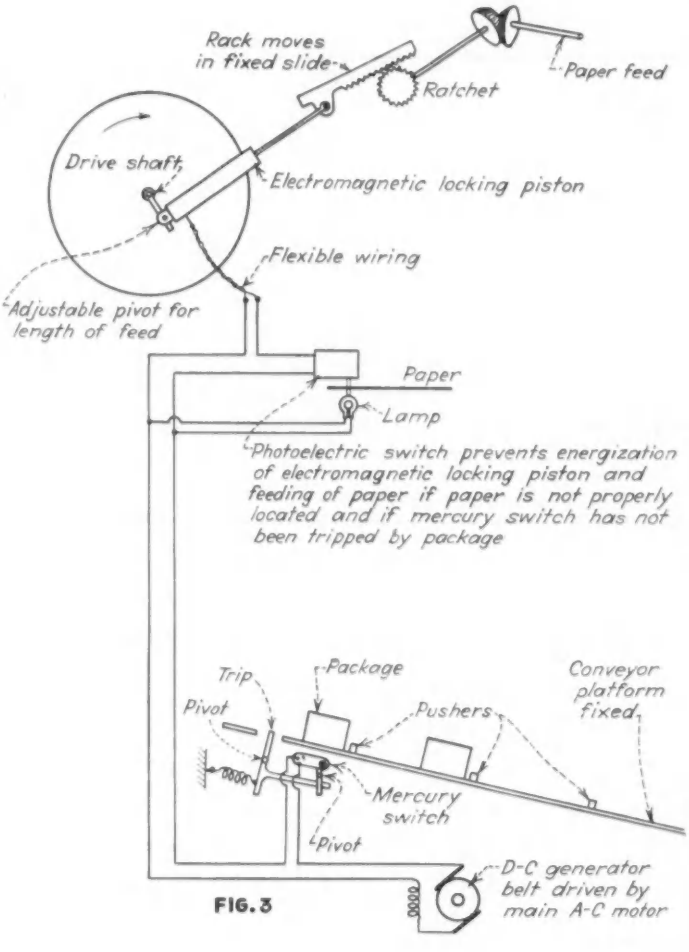
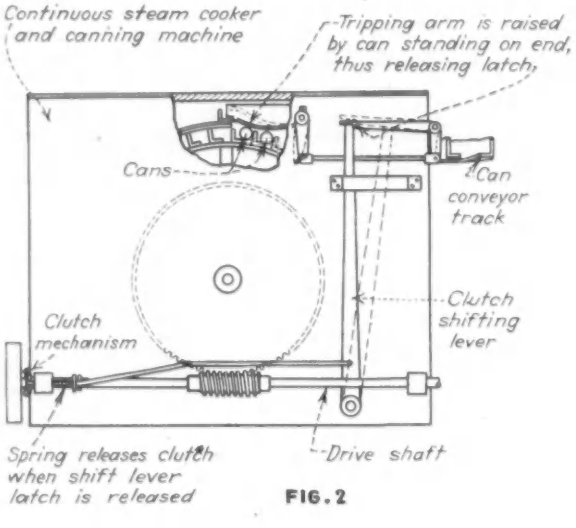


FIG. 3


Continuous steam cooker and canning machine
Tripping arm is raised by can standing on end, thus releasing latch
Cans
Can conveyor track
Clutch shifting lever
Clutch mechanism
Spring releases clutch when shift lever latch is released
Drive shaft
FIG. 2

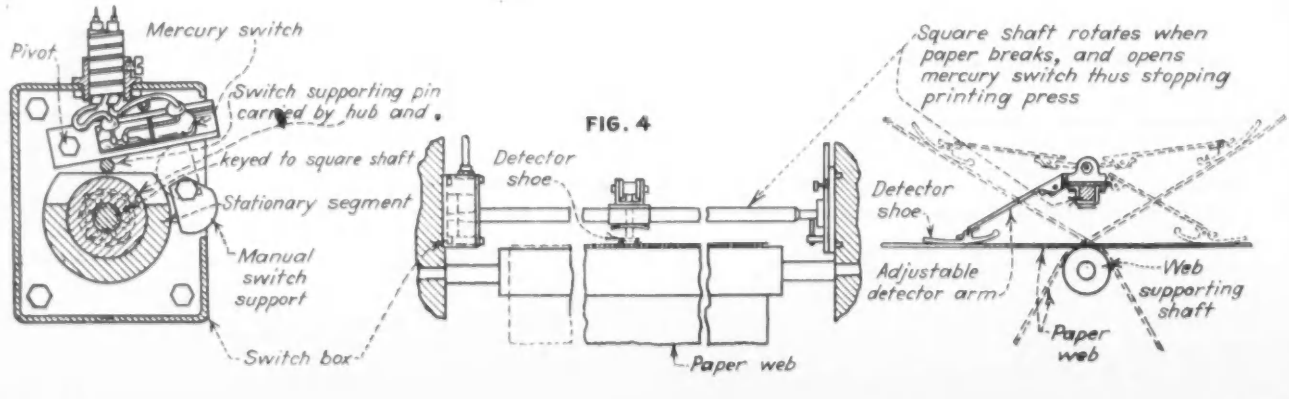


FIG. 4

PROTECT MACHINES AND WORK

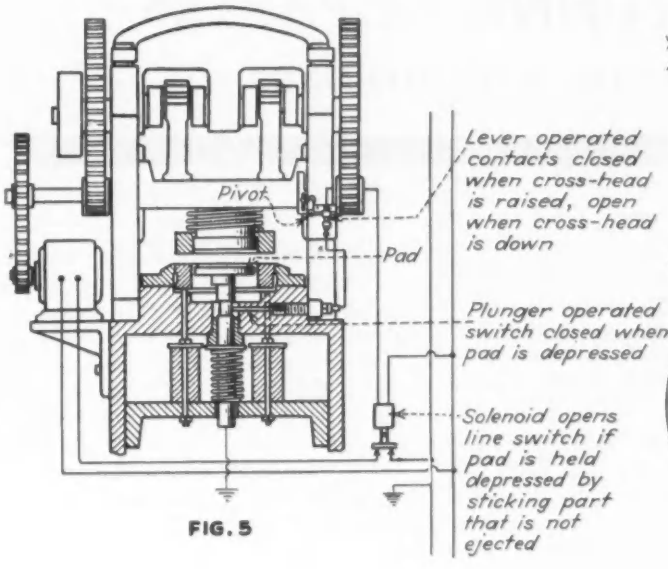

Pivot
Pad
Lever operated contacts closed when cross-head is raised, open when cross-head is down
Plunger operated switch closed when pad is depressed
Solenoid opens line switch if pad is held depressed by sticking part that is not ejected

FIG. 5

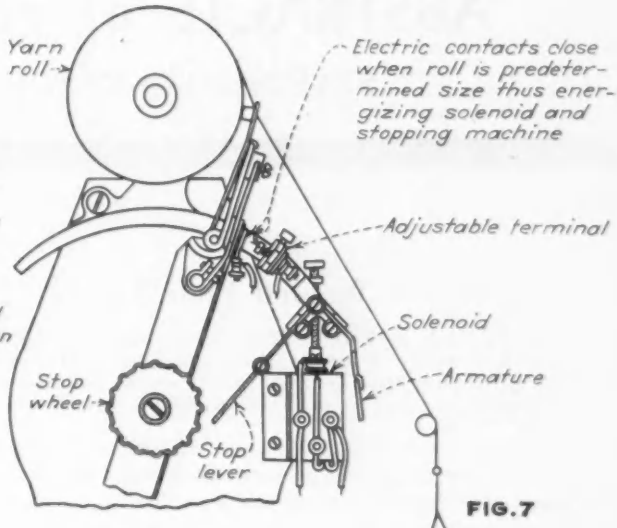


FIG. 7

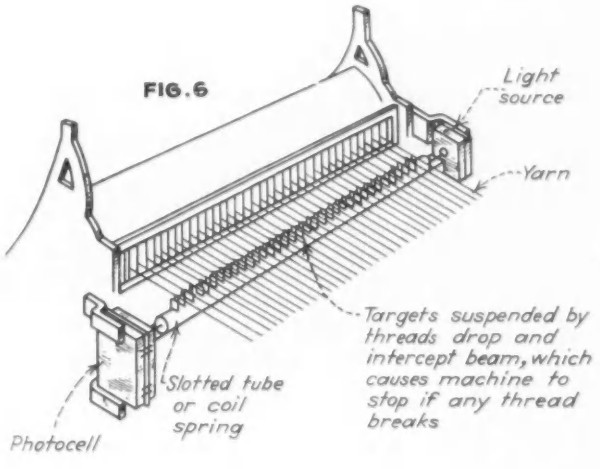
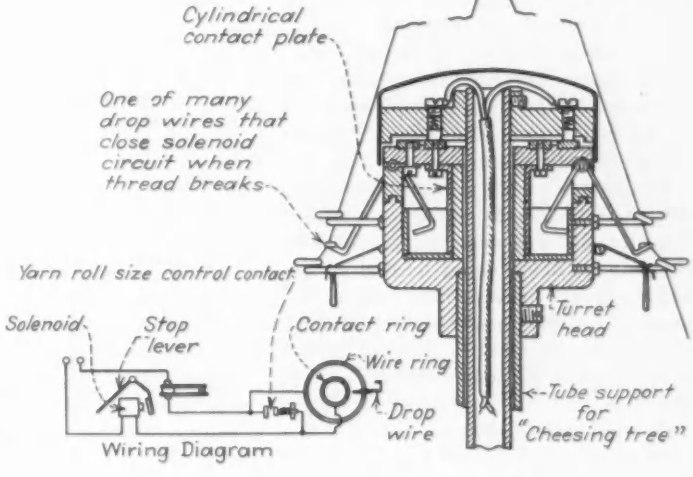

Light source
Yarn
Targets suspended by threads drop and intercept beam, which causes machine to stop if any thread breaks
Slotted tube or coil spring
Photocell

FIG. 6



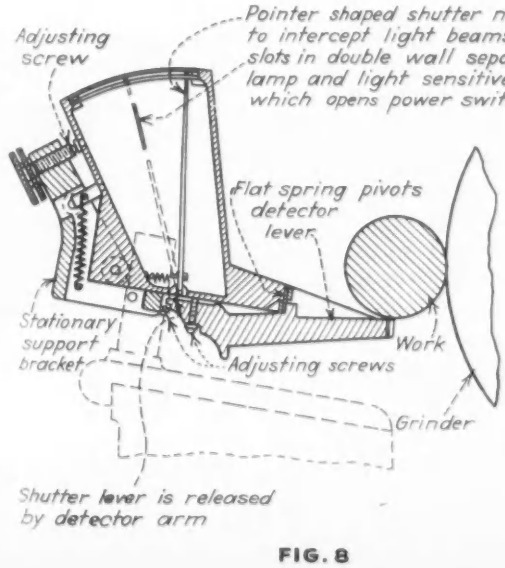

Adjusting screw
Pointer shaped shutter moves to intercept light beams through slots in double wall separating lamp and light sensitive cell, which opens power switch
Flat spring pivots detector lever
Stationary support bracket
Work
Adjusting screws
Grinder
Shutter lever is released by detector arm

FIG. 8

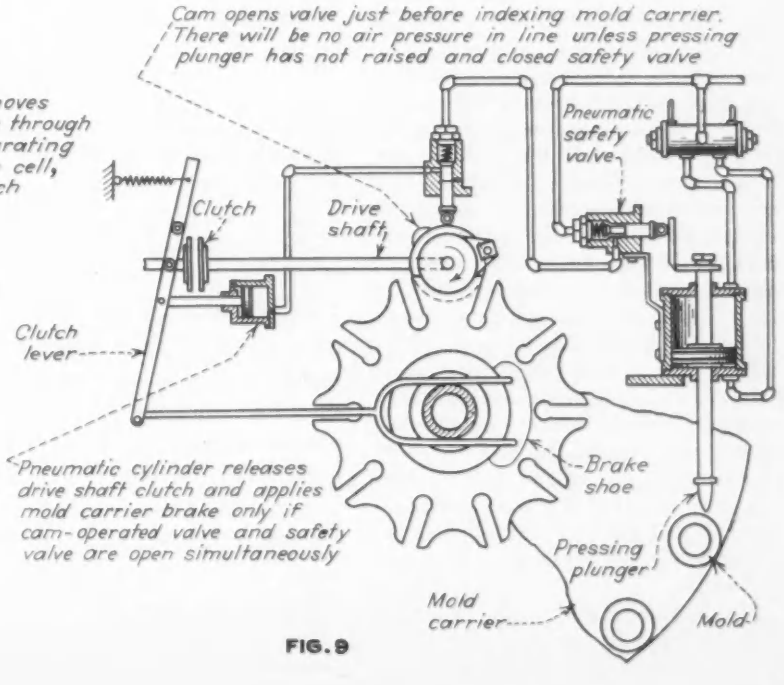

Cam opens valve just before indexing mold carrier. There will be no air pressure in line unless pressing plunger has not raised and closed safety valve
Pneumatic safety valve
Clutch
Drive shaft
Clutch lever
Brake shoe
Pneumatic cylinder releases drive shaft clutch and applies mold carrier brake only if cam-operated valve and safety valve are open simultaneously
Pressing plunger
Mold carrier
Mold

FIG. 9

INDUSTRY AND SOCIETIES

ABSTRACTS of TECHNICAL PAPERS

STANDARDS • READER LETTERS • MEETINGS

Welded Plate Joints

From "A Study of Tensile Properties of Heavy Longitudinally Welded Plate Specimens Simulating Deck and Shell Joints" by Leon Bibber, Carnegie-Illinois Steel Corporation. Presented Nov. 7, 1944, at the annual meeting of the Society of Naval Architects and Marine Engineers.

Cause for failures in welded ships, as indicated by investigations of large and unusual specimens simulating ship constructions, appears to be notches accompanied by differential temperature expansion stresses that are more severe than loading stresses. Apparently also, the author observed, "the clue to the problem of cracking in ships does not lie in inadequate elongation of large welded structures, per se."

Large welded ship plate specimens sustained test loads equal to the full capacity of the steel and underwent elongation almost equal to that of the virgin metal. Cracks in weld metal usually became apparent only when elongation exceeded 10 percent, which is far greater than can be utilized in ship construction. Toughness of Unionmelt weld metal and the heat affected zone of the base metal was indicated by the Charpy notch-bar impact test to be at least equal to that of rolled steel and no more likely to induce propagation of cracks. However, welds often contain flaws that create notches. Also high residual stresses are present in the vicinity of the weld in the "as welded" condition, which may be augmented by stresses caused by atmospheric temperature variation during construction. Tests also indicated that hand welds were little more likely to initiate fracture of a test specimen in static tension than the machine weld.

The first conclusion drawn from results of tests is that good strength and elongation can be obtained in longitudinally welded joints of both the angle types and the flat plate types in heavy plates. A square type of fracture was practically always produced when welded joints were pulled longitudinally but this does not indicate lack of ductility.

Longitudinal cracks in a weld are undesirable, mainly because they may have transverse tributaries, which constitute sharp notches from which failure may start. Small blow holes in a weld only slightly reduced tensile strength of the welded structure, and although elongation was reduced more, neither were considered serious faults because these properties still exceeded the requirements of ship service.

Further conclusions were that abrupt changes in section in a structure are points of weakness even under static loading because of stress concentration and inefficient use of part of the metal. Stress relief annealing considerably increased elongation of both base metal and welded joint test specimens. Joints that were subjected to transverse residual tension had less overall strength and considerably less elongation than those subjected primarily to residual longitudinal stresses.

Cooling of Worm Gears

From "Worm Gear Contact Temperature" by George H. Acker, The Cleveland Worm & Gear Company. Presented at the 27th Semi-Annual Meeting, Oct. 30 and Nov. 1, 1944, of the American Gear Manufacturers Association.

The load carrying capacity of worm gearing is not determined by beam strength of or surface stresses in the gear teeth. The temperature developed by friction at the contact points between a worm and its gear is the controlling factor. A disproportionate amount of the total heat of friction is generated at the contacting high spots where the cooling effect of the lubricant is minimized. The performance of the lubricating film as a coolant, the specific heats of the worm and gear materials and their respective thermal conductivities also contribute to the ultimate temperature attained at contact points.

All of these factors were investigated by means of special worm and gear mountings designed to fit into a convenient speed reducer housing. The worm shafts were through-hardened S.A.E. 4150 steel and the gear material was the conventional copper-tin or copper-tin-nickel bronze. The worm and gear materials also served as thermo-couple elements, developing a thermo-electric potential of two millivolts over a temperature gradient of 460 deg. F., above a 66 deg. F. cold junction.

Scale readings as low as 0.01 millivolts gave an accuracy of about plus or minus 4 deg. F. The temperatures were a weighted average of all instantoneous contact e.m.f. values at the numerous points of contact between worm threads and gear teeth. Numerous curves are given in the paper to present the results of the tests.

Tests on a three-thread worm meshed with a 29-tooth gear on a 5.5-in. center distance showed that, after running in, average contact temperature rise can be plotted as a straight line in the range of input loads from 300 in.-lb. to 1,000 in.-lb. A break in the curve at 1,000-in.-lb. input load is believed to have been caused by a deflection of the gear-

This selection of abstracts of technical papers presented at recent meetings of technical societies opens a new reader service. These abstracts give news coverage on and useful information from papers in the field of PRODUCT ENGINEERING, *and indicate where more complete information on the different subjects can be obtained.*

ing in the mounting, which spread the tooth contact. Subsequent tests of the same gear in a different housing showed a marked drop in average contact temperature rise when the load was decreased from 1,300 in.-lb. to 1,000 in.lb.

At constant load and increasing speed the difference between oil bath temperature and contact temperature decreased, but varied directly with load. The decrease resulted from better lubrication and the greater amount of sensible heat carried away from contact points by the oil film. Thus, within certain limits the amount of heat energy absorbed by a tooth surface element in one cycle of an engagement is reduced at increased speed.

Tests to determine the manner in which contact temperatures are affected by change in oil bath temperature indicated that the difference between these two temperatures at a given speed and load is practically constant. That is, a certain temperature drop is required to transmit heat at a constant rate from the contact zone to the housing walls. Repeated tests at lower speeds, however, showed that the average contact temperatures were not reduced as greatly as the oil bath temperatures. The mass temperature of the gears was found to be 17 deg. F. higher than oil bath temperature in another series of tests.

It is significant that with constant load, increasing the speed of a 50-tooth gear on 5.5 in. centers in the original test housing increased the difference between contact temperature and oil bath temperature. This was explained by the difference in contact conditions prevailing on this 50 to 1 ratio gear set, the dwell of any particular gear tooth element in contact being correspondingly lengthened, thereby altering the lubricating conditions.

When cooling air velocity over the oil reservoir was increased by a fan, the difference between contact temperature and oil temperature was increased somewhat and average contact temperature was reduced. Fan cooling reduced the oil mass temperature by 40 percent, but the reduction in average contact temperature rise was appreciably less.

The author concluded that the tests justified higher ratings for worm gearing at the higher speed range when the oil bath is cooled by an air blast, although further field experience will have to be acquired before standardizing such higher ratings, and a rating method will have to be developed.

Permanent Mold Castings

From "Advantages and Characteristics of Light-Metal Permanent-Mold Castings" by L. F. Swoboda. Presented at the Autumn National Aeronautic Meeting of the Society of Automotive Engineers.

Aluminum and magnesium permanent-mold castings are quality products and should be considered when: (1) superior cast metal structure is desired, (2) smooth surfaces are desired in the as-cast condition, (3) uniform size, weight, and section thickness are desired, (4) reasonably large production quantities are contemplated, or (5) the most economical production is desired for a high rate of production. Many large castings, as well as medium size castings can be produced economically.

Mechanical properties of permanent-mold light metals are substantially greater than those of other type castings. Progressive feeding, together with rapid chill from the metal mold, produce dense, fine-grained castings. Common foundry defects such as dross, air pockets, and porosity are minimized.

While permanent mold castings are not precision products, their dimensional accuracy is between that of sand castings and die castings. Because of their greater uniformity, permanent mold castings can be machined faster and cheaper than sand castings. Less metal to be removed also contributes to lower machining costs as well as to lower material cost, since less metal is required per piece.

In designing light metal, permanent-mold castings one of the chief requirements is allowance for removal of cores and removal of the casting itself from the mold. A minimum number of cores is desirable because their replacement in the mold requires handling time that slows production speed. Extremely long, thin cores should be avoided if possible. Application of the permanent mold process has been broadened by the use of multiple-piece and dry sand cores. However, if the "undercut" that necessitates multiple-piece cores can be eliminated, cost is reduced.

Uniform sections simplify foundry problems and prevent internal strains that may cause cracking. In joining light and heavy sections, a gradual thickening of the thinner section toward the junction helps considerably. Minimum possible section thickness is generally about $\frac{1}{8}$ in. but depends on casting size, pressure requirements, and intricacy. Smoothness of surface is sometimes sacrificed in attaining desired thinness. The dangers of cracking in thin ribs can be minimized by making their edges blunt rather than "full-round." Generous fillets at all wall intersections also help to prevent shrinking and cracking. Location of jig spots and locating points should be marked on drawings.

Plastics for Aircraft

From "The Development and Use of Plastic Materials for Aircraft Construction" by Major Russel M. Houghton, Wright Field. Presented at the Autumn National Aeronautic Meeting of the Society of Automotive Engineers.

A critical examination of plastics for stressed parts was presented by the author, who pointed out that more complete and accurate mechanical data than are now generally available are required if plastics are to be considered for stressed parts. Thus, plastics seldom show a fixed yield point, they creep at room temperature, and they fail to obey Hooke's law precisely. Most test data are valid only under certain conditions, he warned. Molded parts are often of such shape that uniform density and strength can rarely be guaranteed.

In many applications the effects of high humidities and temperature range limit design. Plastics that are but slightly affected by high humidity are polyethylene and polystyrene. All organic insulating materials based on carbon are limited greatly by thermal instability. This property was said to be greatly improved by the replacement of carbon by silicon.

Development of "double-skin" construction was predicted in the next few years because it makes the most efficient use of the material in bending and shear, as compared with sheet-stringer construction. It also eliminates a large number of separate parts.

New Hardenability Test

From "A Hardenability Test for Low Carbon and Shallow Hardening Steels" by O. W. McMullan, Bower Roller Bearing Company. Presented Oct. 16, annual convention, American Society for Metals.

The standard end quench hardenability test was found inadequate by the author for low carbon and shallow hardening steels. He described a test in which one face of a tapered or wedge-shaped specimen is jet quenched and hardness measured along the other face of the wedge. By taking readings on a

face oblique to the quenched face, rather than on one perpendicular to it, as in the standard end quench method, the hardened zones are widened, thus permitting more readings and less error from inaccuracy of spacing. No cutting after hardening is necessary. Consistent results have been obtained on several types of steel.

The wedge test specimen is an answer to one criticism of the standard end quench specimen, namely that only the outside portion of the bar is tested. Wedge specimens check the cross-sections and should show any undue segregation if readings are properly located. However, there is not yet sufficient data obtained by this method to justify adoption of the method as a production test.

Wedges of two designs have been used: Those formed by cutting off the end of a 1-in. round bar at 45 deg. and those cut from a square or rectangular bar to form an angle of 26.5 deg. In order to use the available standard Jominy equipment for quenching, specimens were attached to a small rod on the collar end of shortened Jominy bars. The jet orifice was changed from round to slot opening.

Welded Machinery

From "Trends in the Use of Welded Machinery Parts" by Edward J. Charlton, Lukenweld Incorporated. Presented Nov. 29 at the annual meeting of the American Society of Mechanical Engineers.

Summarizing reasons for trends in utilizing welded construction, the author named comparative first cost, predictability of service, strength characteristics, greater rigidity, weight reduction, wearability, operating efficiency, and natural adaptability as the principal influencing factors.

Welding specifications were said to be in need of development. The author concluded that valuable and important work can be done by a coordinating agency in compiling and correlating design criteria, since a sound foundation of much experience and basic information with service records exists. His conviction was that " the commercial designer literally has no guiding standards with the exception of nomenclature."

However, experience proves that welded machinery parts can be designed to withstand unusual and indeterminate stresses and that a welded joint can be so designed and executed that it need not be regarded as a joint. Otherwise a fracture should follow the weld when reached by the fracture. If properties of the material are to be utilized efficiently, designers were warned that the metal throughout the structure must be disposed properly, that is, so that design loads are carried with the most uniform stress or with the maximum moment of inertia possible. Welds must also be fully accessible to welders if maximum strength is to be obtained.

Use of welded construction as insurance against service failure is meant by predictability. If it is sometimes obtained at added cost or premium, the return may be in the form of eliminated repair time and costs. Strength improvement has occurred in many instances when it was not possible to design a steel casting with adequate strength. In one instance the combination of a steel casting and steel plate shapes by welding eliminated periodic replacement of a 6,000-lb., 116½-in. diameter end for a rotary mixing unit.

Maximum rigidity was considered in combination with minimum weight. As an example, the use of box-shaped stiffeners welded to the back of a plate was a means of achieving this result. Weight reduction was illustrated by a number of photographs of parts in which the design permitted a part of less weight than when fabricated by casting.

Increased operating efficiency was shown to be the result not only of reduced weight but also of other factors in machine operation. A steam heated dryer of welded steel, for example, reduced steam consumption nearly 40 percent because pressure could be increased.

A proof of ability to withstand unusual stresses is the record of a welded diesel engine frame in a submarine that had been subjected to numerous depth charges. Although 126 fractures were found, none started in the welds or parent metal of primary load-carrying members. Most started at stress raisers and others at openings. Some of these members, which were dynamically loaded in tension, had two or more butt welds within their length.

Welding components are most commonly hot rolled flat steel plates cut into any shape. However, bent and formed plate, rolled and extruded shapes, steel castings and forgings are being welded together successfully in all combinations. This trend was established by economy and gives considerable freedom in design.

Critical Speeds of Flexible Rotors

From "A General Method for Calculating Critical Speeds of Flexible Rotors" by M. A. Prohl, General Electric Company. Presented Nov. 29, annual meeting, American Society of Mechanical Engineers.

Existing methods for determining critical speeds are subject to a few limitations. Methods that permit the calculation of higher critical speeds as well as the fundamental, involve computations so complicated as to be impracticable for any but the simplest of rotors. Methods for which the computations are comparatively simple, such as the familiar methods of Rayleigh and Stodola, lack generality in that critical speeds other than the fundamental cannot be definitely determined.

The tabular-calculation method presented in the paper combines generality with comparative simplicity. In general, for any assumed speed of rotation, bending-moment and deflection diagrams can be constructed which satisfy three of four required boundary conditions. Only if the assumed speed of rotation is exactly equal to a critical speed can the fourth boundary condition also be satisfied. Hence, by plotting the discrepancy in the fourth boundary condition as a function of the assumed speed, and noting where the discrepancy becomes zero, the various critical speeds can be obtained.

Any critical speed—first, second or higher—can be calculated with equal ease. The rotor can have any number of spans and its cross-section can vary in any prescribed manner provided circular symmetry is maintained. Any number of disks or symmetrical masses can be attached. The shaft journals may be considered to be elastically supported in the bearing with respect to both deflection and tilting of the journals, the elastic constants must, however, be symmetrical. The so-called "gyroscopic effect" associated with the moment of inertia of the disks on the rotor can be readily taken into account.

This method gives an exact solution for the critical speeds of the ideal system. Hence the accuracy of the method for an actual rotor depends on how closely the ideal system and boundary conditions represent the actual rotor and its bearings.

Stresses in Fan Rotors

From "A Simplified Method of Determining Hoop Stresses in Fan Rotors" by G. F. Lake of Imperial Chemical Industries, Ltd. Presented November 28, 1944, annual meeting, American Society of Mechanical Engineers.

A simple, approximate method for determining hoop stresses in rotors containing a central hole is presented to replace the exact and time consuming method described in many textbooks. The author shows that in applying the approximate method to fan rotor design, the likely error in the maximum hoop stress is an overestimate of only about 5 percent.

The basis of the approximate method is an assumption that the rotor section displaces radially under stress without distortion. The only quantities that require lengthy computation are the radius at which actual stress is equal to mean stress across the rotor section, and the radius of gyration of the rotor section about the axis of rotation.

Resorcinol-Formaldehyde Glues

From "Resorcinol Resins and Adhesives" by Philip H. Rhodes, Pennsylvania Coal Products Company. Presented Nov. 13, 1944, at the Fall meeting of the Society of the Plastics Industry.

Completely waterproof and non-corrosive glues that are cured at room temperature or elevated temperatures by the addition of a formaldehyde solution or para-formaldehyde powder, which eliminates an irritating effect produced by free formaldehyde, have been developed. Principal applications of these resorcinol-formaldehyde glues have been (1) in paper and fabric laminates which, the author states, have greater strength than when made with phenol-formaldehyde resins; (2) in grinding wheels where wearing life and efficiency were said to be double that given by phenol-formaldehyde resins, and (3) in the manufacture of heavy laminated timbers for small boats for the Navy. Wide application has also been found in plywood tubing.

In addition to wood, resorcinol resins have been employed as bonding agents in assembly gluing of laminated and molded plastics and synthetic rubbers. Metal surfaces, after application of baked priming coatings of certain thermosetting resins, have also been successfully bonded together.

Complete water resistance has long been sought in adhesives. Although it was obtained in the urea-formaldehyde glues, the author stated room temperature cures required acid catalysts that cause slow but significant deterioration of the resin and glue line. Room temperature cure of phenolic resin adhesives, which are completely water and acid resistant, requires acid catalysts that decompose wood, he said. Intermediate temperatures and less concentrated acids solved this problem.

Although resorcinol-formaldehyde glues were developed for room temperature bonding, it was found that the curing time of several hours could be greatly reduced by increased temperature. For example, a 5 to 6-min. cure is effected at 180 deg. F., and by using high frequency heat, a cure has been attained in 1 min. A temperature of 140 deg. F. has been shown practical for producing laminated white oak timbers for ship use. Pressure of 50 lb. per sq. in. is used in production.

Electronic Controls

From "Electronics Instruments for Industrial Processes" by P. S. Dickey and A. J. Hornfeck, Bailey Meter Company. Presented Nov. 28, annual meeting, American Society of Mechanical Engineers.

Electronic instruments can be employed for process control in many applications where mechanincal or electro-mechanical instruments have been used. The principal advantage, the authors state, is simplification and standardization of instruments for many kinds of process control.

Electronic instruments must not be of complicated delicate construction or be susceptible to external disturbances. They should have, therefore, the following design characteristics: (1) A sturdy construction which must be capable of withstanding not only vibration but a wide range of ambient temperature and humidity conditions. (2) Reliable performance under all operating conditions. (3) Continuous operation for long periods must be possible without replacement of tubes. (4) Calibration must remain accurate. (5) Maintenance must be simple and inexpensive and not require highly skilled technicians.

The extremely high speed at which electronic instruments operate is an important advantage. Measurements can be transmitted considerable distances without serious loss in accuracy or speed of response. An electronic device can handle several variables without specially designed accessory units. The extent of possible standardization is shown by the authors' list of 16 different types of measurements that can be made with a single electronic instrument and recording device. The authors describe the operation and design of electronic instruments meeting their requirements and show how they are employed.

End Quench Hardenability

From "Further Developments of the End Quench Hardenability Test" by Charles R. Wilks, Earnshaw Cook, and Howard S. Avery, all of American Brake Shoe Company. Presented Oct. 16, annual convention, American Society for Metals.

Refinements in the end quench hardenability test to overcome a lack of assurance that identical metallographic structures are achieved in the standard test were described by the authors. A hardenability test bar, which is selectively quenched from both ends, was developed to obtain closer correlations with the thermal histories of quenched plates than are possible with the standard single end quench specimen.

It was pointed out that unless the cooling at a given point is sufficiently rapid to develop maximum hardness, and unless it corresponds closely to that of the selected section, the metallographic structures may not be the same. Experimental cooling curves were presented as evidence supporting the proposed modification of the test.

The double end quench test bar was developed specifically to match the thermal histories at the center of flat plates. The correlation for other sections has not been determined. The possible modifications in the shape of the test bar and/or of the quenching technique, which might permit similar correlations with other types of sections, may be such as to limit broader application of the technique.

While the shapes of the cooling curves obtained are affected by chemical composition, the relationship between length of double end quench test bars and thickness of plate, is considered to be independent of composition. This must be examined further empirically. The present correlation is to be extended to plates 2 in. and more thick. Indications are that cooling curves can be extrapolated for any steel.

Discussions and Comments From Readers

ADDITIONAL DATA FOR FASTENERS INSERT

Several items of additional information that should have been included in the special section on "Screws & Fastenings" in December, 1944, PRODUCT ENGINEERING are presented below.

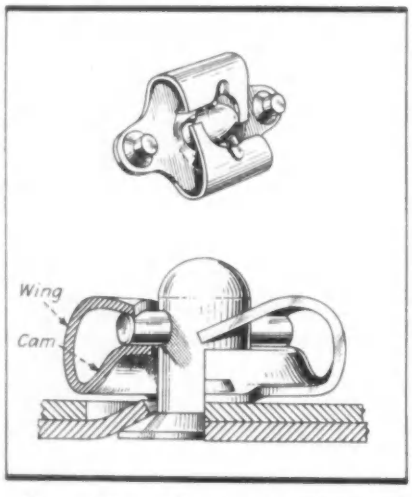
CLINCH NUTS. On page 12 the credit lines for the two types of clinch nuts shown were transposed. The upper one is made by FabriSteel Products, Inc., and the lower types by Thorrez & Maes Manufacturing Company.

AERO-THREAD SYSTEM. On page 4 the Aero-Thread system shown involves special threading. The same principle applies to the Heli-Coil system in which all the threads are standard. Both systems were developed by Aircraft Screw Products Company.

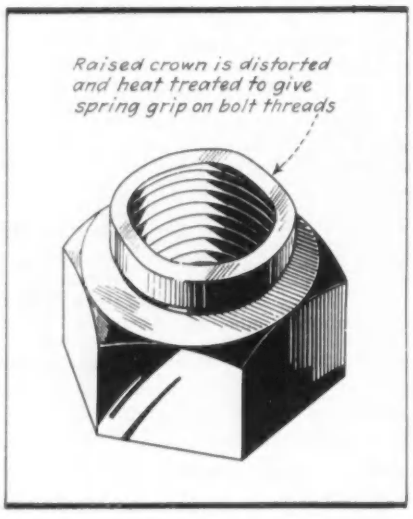
LOCK WASHERS. External, internal and countersunk tooth-type lock washers similar to those shown on page 9 are available in steel and bronze with a cadmium finish from Thompson-Bremer & Company.

Many manufacturers of lock washers such as those shown on pages 8 and 9 also sell these units preassembled on fasteners. Thus, the KnolinK, Springlox, external and internal tooth-type lock washers are preassembled by Reliance Spring Washer Division, Eaton Manufacturing Company, and sold under the name of Springtite Semblies.

QUICK-DETACHABLE FASTENERS. From the array of quick-detachable fasteners shown on pages 14 and 15 there was omitted the Airloc, made by United-Carr Fastener Corporation, illustrated below:



LOCK NUTS. In the spread of lock nuts made in the U.S.A. and Canada, pages 6 and 7, the Lamson lock nut, made by Lamson & Sessions Company, was omitted. It is shown here:



RECESSED-HEAD SCREWS AND BOLTS. Knurled socket-head cap screws with a hexagon-shaped recess like that shown on page 12 are made by Standard Pressed Steel Company.

Phillips recessed-head screws and bolts are made by 24 manufacturers who are listed each month in an advertisement in PRODUCT ENGINEERING.

VIOLATION OF NEWTON'S FIRST LAW SUGGESTED BY READER'S PROPOSITION

To the Editor:

Herewith is a proposition that I feel sure will interest many of your readers. It would be very interesting to see what those of them who have studied college physics think of it.

PROPOSITION:

A metal ball weighing 10 lb. is projected vertically up from the earth. Neglecting the influence of the air on the motion of the ball, and considering the forces acting on it at the instant it comes to rest at the top of its path, we find it under the influence of two forces which have the same line of action, the same magnitude, but opposite senses. The indisputable fact that the ball descends despite the fact that at the instant under consideration it is being pushed up by a force in exact equilibrium with the force that is pulling it down is a phenomenon—a violation of Newton's First Law of Motion—that scientists have never satisfactorily explained.

Most physicists and teachers of applied mechanics think they know exactly how to explain the phenomenon, but when their explanations are closely examined it is invariably found that they rest on the untenable assumption that there is some difference—other than a difference of sense—between an inertia force and the force in equilibrium with it.

Kelvin and Tait, in their "Treatise on Natural Philosophy," Vol. I. p. 241, translate Newton's First Law of Motion from the Latin as follows:

"Every body continues in its state of rest or of uniform motion in a straight line, except in so far as it may be compelled by force to change that state."

Now the 10-lb. ball referred to in the proposition is at rest at the instant it reaches the top of its path; moreover, there is no force to compel it to change that state, for it is acted on by two forces—the downward pull of gravity and the equal upward inertia force—in equilibrium. Yet, as we know, the ball does change its state of rest. It seems obvious, therefore, that here we have a violation of Newton's First Law of Motion. —WILLIAM H. RASCHE

TABLES IN OCTOBER ARTICLES LACKED CREDIT LINES

In the article "Phenolic Laminated Sheet for Low-Pressure Hot-Forming," published in the October, 1944, number of PRODUCT ENGINEERING, pages 674 to 677, Tables III and IV should have been credited to Westinghouse Electric & Manufacturing Company.

EDITORIAL ON PATENTS BRINGS PRAISE FROM TOULMIN

To the Editor:

I have noted with interest your editorial about patents. ["The Drop in Patent Applications," December, 1944, page 805.] You are entirely correct in what you say. There is plenty of work going on in substantial inventions. My firm has one of its largest businesses in 70 years. We have found no fall-off in our patent applications.

—H. A. TOULMIN, JR.

FIELD RESEARCH ARTICLE AIDS IN SOLVING PROBLEM

To the Editor:

I have read with a great deal of interest your lead article "Field Research Studies Essential to Product Development" by James O. Peck in the December, 1944, number of PRODUCT ENGINEERING. We have had a field research department for quite some time but have not been getting enough from it. Mr. Peck sums up in three pages exactly what we have in mind.

—C. M. T., *Vice Pres.*

REDEDICATION

An Obligation to Our Fighting Men

DURING the last few weeks we have been forcibly reminded that so long as we still are fighting either of our major foes, first claim upon the productive resources of the United States—its manpower, materials, utilities, and industrial facilities—must be the production and delivery of munitions and war supplies. All other claims are secondary. No responsible citizen would have it otherwise. For in this war even more is at stake than our existence as a Nation. We dare not forget that we are engaged in a struggle that challenges the fundamental values upon which our civilization has been built.

It is not easy to list the values that we are fighting to uphold. They have been clothed in a variety of shapes over the centuries. They will assume new forms in the years ahead. But they have an inner consistency that free men the world over can feel and recognize: the right of the commoner against the noble, the right of the individual against the state, the right of trial by jury, the right to vote, the right to an education, the right to freedom of speech and worship, the right to work in a sphere of one's own choosing, the dignity and the equality of the individual under the law—these are our cultural heritage, painfully won and often precariously held over the ages, always to be rewon, redefined and buttressed by each succeeding generation of men.

The preservation of this vital core of value, and its transmission to our sons and daughters depends upon our victory in this struggle. So those things which are essential to victory must come first. And since the production of war munitions in overwhelming volume and quality can hasten that victory and save countless lives of our fighting men, no effort that will contribute to this end should be regarded by us as a sacrifice.

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The present is no time for self-congratulation upon our achievements either in the theatres of battle or of production. The mounting casualty lists should suffice to curdle the savor of any such indulgence. The most that can be said in reasonable taste and good conscience is that performance in both fields is such as to warrant our firm confidence that we can carry to successful completion the tasks that remain to be done.

Nor is there profit in even observing, much less deploring, that the tasks ahead are more formidable than those which were defined for us a few short months ago. Then, all of us—military leaders, government officials, workers, and business men—were riding a crest of optimism as to an early end of the war in Europe and as to the character and dimension of the war against Japan. Already we had begun to turn anxiously toward the problems of reconversion which then seemed so near at hand. Schedules for war production, based upon the best available estimates of need, called for a 5 billion dollar reduction from 1944 performance, even though we might have to continue a two-theatre war, and for a 40 percent reduction in the event of an early victory in Europe.

Today, those forward estimates have been revised sharply upward. That is true both of the 1945 requirements to meet the needs of a two-theatre war, and of requirements for the Pacific war once the European phase is ended. For this upward revision four chief reasons are responsible:

1. European battle experience has shown markedly greater use of expendable munitions than was provided in the formulae upon which our original production schedules were calculated: the result has been a depletion of inventories on a scale that would become dangerous if allowed to continue.
2. Experience has also demonstrated the need for new types of weapons or increased complements of some existing types to match new enemy equipment or tactics.
3. A less easy optimism as to the early ending of the European war has given rise to a growing disinclination to gamble on the approximate date.
4. An increasing conviction prevails that the war against Japan may require ground-army operations on the Asiatic mainland on a scale greater than originally premised.

But if these changes in the fortunes and outlook of war have raised our estimates of military requirements, may not subsequent favorable changes in the military situation cause them again to be revised downward? It is entirely possible. But our military men have learned that they cannot safely discount what *might desirably happen* as something that *will happen*. Those working on the production front also must learn that lesson. Fortunately, the record shows that we have been able to maintain a war production almost equal to that of the rest of the world combined, even while we produced for civilian use on a scale that has been large even by our

own pre-war standards. So we have ample margin to whip whatever war job may be required of us. As now defined, the task will not be easy. But it *can* and *will* be done.

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What, then, is the production task with which we are charged? Our 1945 production for the two-theatre war now calls for the substantial maintenance of the over-all levels reached in the latter months of 1944. But there is a shift of emphasis. Almost half of the programs for specific equipment items are declining. A few are scheduled to hold level. About 45 percent are scheduled to rise sharply. That means that workers and facilities must be shifted to man the expanding programs. At the same time the armed services are calling for many more men than can be supplied from those who become newly eligible to the 18 year old age group. That means further drafts upon war workers. It means also replacements for them when they are taken from the expanding programs. Finally, events demand that we produce as much as possible of many items during the first half of 1945.

Our task, then, is one of intensified effort for the immediate future, with multiple readjustments at a stage when adjustments are hard to make. Materials for which demand was easing as pipe-lines were being drained in anticipation of falling schedules again are tight as the pipe-lines are being refilled to meet augmented requirements. Men, women, and facilities must be shifted from less essential to more essential tasks. What must be done will be done. But unless there is much voluntary accommodation, it will be necessary for us to suffer a formidable amount of governmental direction which none of us likes, many of us deeply resent, and all of us, when personally affected, volubly protest. The more we police ourselves, the less we shall be policed.

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Even after Germany has been defeated, we shall still face a far from light production requirement to continue the war against Japan. As currently defined this phase might require war expenditures at something like $70 billions a year, an over-all reduction of approximately 20 percent from the $89 billions spent in 1944. Reduction in munitions output would be somewhat greater, probably from 25 percent to 30 percent below 1944 levels. But it is important for us to acknowledge that the reduction is going to be substantially less than the 40 percent previously estimated.

Only a few months ago there were those who questioned sharply the possibility that we might need 60 percent of current munitions output to win the Japanese war. Now the judgment of the military is that 70 percent will be none too high.

Actually the latter level would represent an increase of little more than 50 percent above what now is being produced for the Pacific area. This, certainly, is a modest estimate when we reflect that we shall inevitably more than triple the Army forces assigned to that theatre.

Such a program probably would give us a current munitions supply from three to four times that produced by Japan, but it is believed that we shall need that much to compensate for the advantages derived by Japan from the fact that she will be fighting a defensive war, from the volume of her accumulated stores, from her prepared positions, her shorter lines of supply and transport, and from her large troop reserves, the bulk of which we have yet to meet in battle. Certainly our present 3 to 1 production edge over Germany does not appear to be excessive.

The more modest V-E Day cuts contemplated by the present plan will mean a less acute reconversion problem when they are made, but will leave a greater one to be met at the end of the war. They will mean probably a net increase of not more than 4 million workers available for civilian work during the transition period. Their orderly absorption should present no embarrassing problem. Indeed, we now are warned by Washington that war production following V-E Day may require the protection of considerably closer control than was contemplated under the 40 percent cuts previously expected.

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In short, we face for the immediate future a more difficult production job. It is made the more formidable by the fact that we had dulled the keen edge of our will to produce by our premature expectation of a reduction in requirements. Now we are told that the trend of war production for the immediate future is up, that it is unsafe to discount the date of victory in Europe, and that the amount of leeway for reconversion after the defeat of Germany is less than had been anticipated.

Accordingly, we must rededicate ourselves to the task of driving war production up. We must do without some of the things that we have enjoyed on the civilian front rather than demand more of those things; we have still to devote our abilities and energies first and foremost to the demands of war.

Whatever will assure and hasten victory must have first place in any statement of American policy.

Without victory, our aims, and the underlying values upon which they are based, will be extinguished, blotted out by the opposing aims and values proclaimed by our enemies.

The needs of our fighting men must be put first. For, unless we win the war, the National aims and policies of the United States will cease to have meaning in the world.

President, McGraw-Hill Publishing Co., Inc.

New Books

Theory and Application Of Electron Tubes

HERBERT J. REICH. 716 *pages*, 5½ x 8¾ *in., green clothboard covers. Published by McGraw-Hill Book Co.*, 330 *W. 42nd St., New York* 18, *N. Y. Price* $5.

A new second edition brings this book up to date with developments of the past five years and incorporates many improvements in presentation, arrangement and style that have been suggested or suggested themselves since the first edition was published. The volume presents the basic principles applicable to radio engineering problems, as well as to industrial electronics, power control, electrical measurements and other fields of use. The chapters on detection and modulation, and on oscillators have been almost completely rewritten.

Machine Designers' Guide

K. W. NAJDER. 281 *pages*, 5½ x 8¼ *in., green clothboard covers. Published by Machine Designers' Guide, Lake Orion, Mich. Price* $2.75.

This third edition of this handbook has been expanded to include a section of 25 pages treating the problems of flight which are of interest especially to the airplane industry. Data are presented covering parasite drag, wing characteristics, lift and drag coefficients of airfoils, performance under various conditions and selection of propellers. The first four sections of the book are a collection of reference tables, formulas and reference data dealing with construction of curves, mechanics, graphics and strength of materials. Section V, about 100 pages, is devoted to miscellaneous examples to illustrate the application of engineering formulas.

Centrifugal Pumps and Blowers

AUSTIN H. CHURCH. 308 *pages*, 5½ x 8¼ *in., blue clothboard covers. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y. Price* $4.50.

This book does not attempt to develop new theories or go into advanced problems. Starting with a nomenclature of centrifugal machines it covers the basic principles of fluid flow, thermodynamics, design, construction and application of centrifugal pumps and blowers. Considerable attention has been devoted to details of design as well as the problems involved in the calculation of disk stresses and critical speeds. Tests of both centrifugal pumps and blowers are described as well as the instruments required for such test procedure. A chapter has been devoted to the problems and instruments used in centrifugal-blower regulation. Clarification of text matter has been accomplished through the liberal use of examples. Problems and answers have been added to the end of each chapter to allow the reader to test his grasp of the subject.

Plastics Molds

GORDON B. THAYER. 136 *pages*, 6 x 9 *in., red clothboard covers. Published by American Industrial Publishers*, 312 *Fairmount-Cedar Building, Cleveland* 6, *Ohio. Price* $3.50.

Texts on mold design are relatively rare, hence this revised and enlarged edition of Mr. Thayer's previous book "Plastics Mold Designing" is a welcome addition to the technical literature. More than twice the size of the first edition, the new book contains 20 chapters on mold design, more than 80 illustrations, and an enlarged nomenclature listing. Several specialists, C. Huber Whitlock, Don F. Hoffman, Thomas J. Lester, William F. Dewar and F. G. Woodiwiss, have contributed to the work. New chapters in this edition include "Finishing Methods and Equipment," "Loading the Injector Mold," "Direct and Indirect Ejector Systems for Injection Molds," "Molding Screw Threads in Plastics" and "Practical Points in Mold Design and Construction."

Sampling Inspection Tables

H. F. DODGE *and* H. G. ROMIG. 106 *pages*, 5½ x 8½ *in., blue clothboard covers. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y. Price* $1.50.

The sampling inspection tables presented in this book were earlier published in the Bell System *Technical Journal*. In the necessities of wartime production, the tables have been found widely useful. This book has been prepared to meet the demand for reprints. A brief introduction has been added to the three original papers. Chapter I outlines some of the factors to be considered in setting up inspection plans and develops a method for minimizing the amount of inspection. Chapter II covers double sampling, the "average outgoing quality limit" and the mathematical background of the tables. Chapter III outlines the shop procedures for applying the tables.

Design Data—Applied Mechanics

Journal of Applied Mechanics Reprint Series. 48 *pages*, 8½ x 11 *in., paper covers. Published by the American Society of Mechanical Engineers*, 29 *W. 39th St., New York* 18, *N. Y. Price* $1.50.

The material in these Design Data sections is a concise presentation of technical information drawn chiefly from papers previously published in the A.S.M.E. *Journal*. To make this material readily available, these articles are being published in booklet form. Book 1 contains "Stress and Deflection of Circular Plates," A. M. Wahl and S. Way; "Stress and Deflection of Rectangular Plates," I. A. Wojtaszak; "Circular Beams Loaded Normal to the Plane of Curvature," M. B. Hogan; "Helical Compression and Tension Springs," A. M. Wahl; "Thermal Stress," J. N. Goodier; "Factors of Stress Concentration Photoelastically Determined," M. M. Frocht; "Torsional Stresses in Shafts Having Grooves or Fillets," L. S. Jacobsen; "Stresses in Pressure Vessels," J. L. Maulbetsch and M. Hetenyi; "Data Sheets for Design of Piping," H. E. Mayrose; "Design of Press- and Shrink-Assemblies," O. J. Horger and C. W. Nelson; and "Working Stresses," C. R. Soderberg.

Sheet Metal Theory And Practice

JOHN C. BUTLER. 173 *pages*, 8 x 11 *in., gray cloth covers. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y. Price* $3.

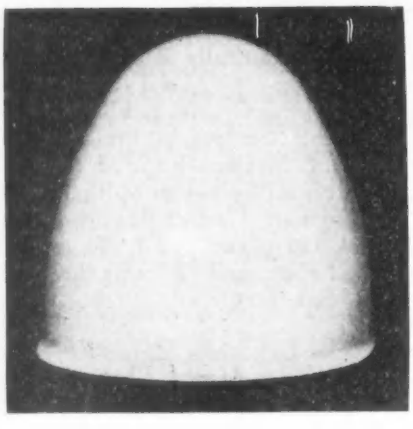
Written to fill a need for a suitable textbook and aid in quickly training workers for the sheet-metal shop of a large West Coast Navy Yard, this book is suitable for courses in high schools and other vocational institutions, or can be used as a sheet metal fabrication handbook for general application of sheet metal design. The book contains 13 chapters dealing with tools and machines, welding, riveting, soldering, joint design, ship terms, blueprint reading, use of templates and patterns, material allowances, ventilation and heating, furniture and compartments, materials, and shop practice. The introduction covers workmen's responsibilities, safety, and shop and job organization. Close to 700 reference items are indexed.

NEW MATERIALS AND PARTS

Single-Coat Enameling Steel

Inland Steel Co., 43 E. Ohio St., Chicago 11, Ill.

White or light pastel single cover-coat vitreous enamels can be applied directly to Ti-Namel steel without prior application of a base or ground coat of enamel. The thinner coat of enamel thus produced, 0.006 to 0.009 in. for white, is less liable to chip and has a longer service life. Shop reoperation, edging and scrap are reduced and lower temperature and shorter time for firing are permitted. Research showed that titanium, when added to steel in a quantity dependent upon the amount of carbon, would eliminate

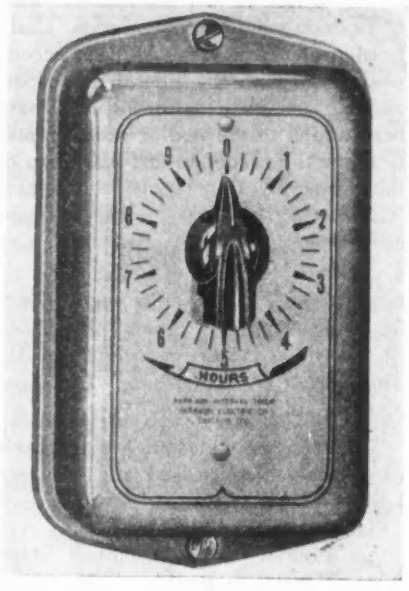


pitting, black specking and blistering when the steel was enameled. Drawing properties of Ti-Namel steel are said to be superior. It does not age-strain and shallow panels of large areas, such as stove end panels, remain flat and true to required shape and form after drawing because of the resistance to sagging of the steel.

Timer

Paragon Electric Co., 37 W. Van Buren St., Chicago 5, Ill.

Adaptable for processing and other applications, Model 2500 timer can be preset to control a circuit up to 20 hr. It has a single-pole, double-throw, 1,000-watt capacity, enclosed switch; self starting, slow speed, industrial type, synchronous, sealed motor; ten time ranges from 0 to 15 sec. through 0 to 20 hr.; and corrosion-resistant treatment for all parts. The motor pinion

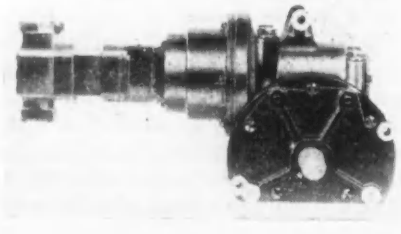


and wheel are the only exposed parts. No energy is required of the clock motor to trip the switch at the end of the preset time. The timer is available in all types of inclosures and can be mounted on a panel or directly to the surface of the equipment it is to control. Overall dimensions are 4⅞ x 3⅛ x 2 in.

Door Actuating Unit

Electrical Engineering & Mfg. Corp., 4606 W. Jefferson Blvd., Los Angeles, Calif.

Built especially to meet exacting installation conditions and to close weight limits for aircraft use, an electric oil-cooler door actuating unit has been designed to fit an existing airframe section where only minor structural changes were permitted. A ⅛-hp. thermally protected motor equipped with magnetic clutch and brake forms the heart of this motor-driven gear reduction unit. Compound planetary reduction of 478 to 1 is provided, with

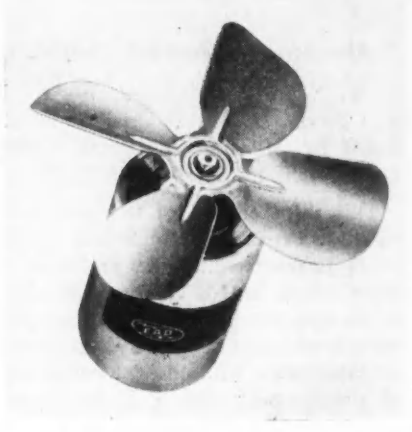


an additional worm and sector reduction of 30 to 1, giving a total reduction of 15,000 to 1. Maximum torque on the drive shaft is 6,000 in. lb. The unit is for use in a 28-volt system. Standard motors are available as such, or they can be equipped with clutch and brake, cooling fans, gear trains, limiting devices and controls, or any combination indicated by conditions.

Axial-Flow Blower

Eastern Air Devices, Inc., 585 Dean St., Brooklyn 17, N. Y.

Delivering 170 cu. ft. per min. of air (NEMA code), the Model J 80 A axial-flow blower operates on 60-cycle, 115-volt, single-phase current. Speed is



3,100 r.p.m. Input is 12 watts and starting torque is 1 oz. in. A 1-mfd. condenser is required. Motor diameter is 1¾ in., fan diameter is 4 in. and overall length is 3⅛ in. Weight is 16.5 oz.

Engineers' Glass

Engineers Specialties Div., Universal Engraving & Colorplate Co., 980 Ellicott St., Buffalo 8, N. Y.

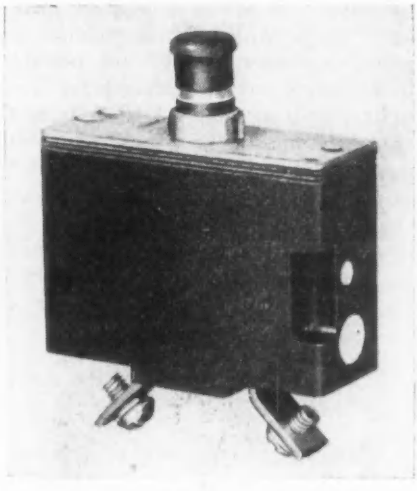
Two new types of detail engineers' glass have accurately ruled blue lines, similar to graph paper, that disappear when drawings are reproduced. The first of these glasses has a sheet of translucent vellum cemented over the ruled lines. Layouts are then made directly on this vellum in either pencil or ink. Charts so drawn can be used for inspection directly on the viewing screens of com-

parators. They can also be used as templates on some types of contour grinding machines. The other type of glass is for scribing without having to make involved mathematical computations. Scribing is done through a red coating and the blue lines also are removed by the scribing tool. The result is a negative—clear lines on an opaque background. These glasses are available for magnifications of 10X, 20X, 25X, 31.25X, 50X and 62.50X.

Push-Pull Circuit Breaker

Regulator Div., Square D Co., 6060 Rivard St., Detroit 11, Mich.

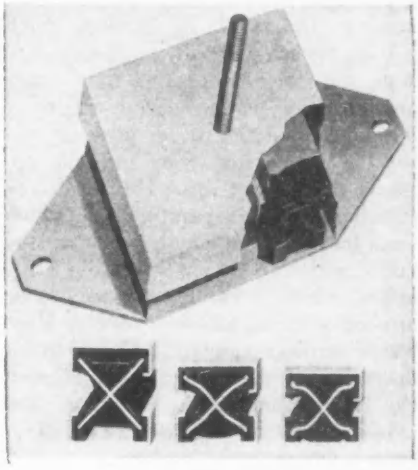
Switching and protection similar to toggle-type breakers and against accidental or careless operation of vital circuits are provided by the Class 9311 Type A push-pull aircraft circuit breaker. A definite pull action is required to open the breaker manually. The manual reset button, black at top, is provided with a red hand to indicate trip in daylight and a luminescent band to indicate trip in darkness. The bimetallic trip element gives time-limit protection against small momentary overloads as well as instantaneous protection on heavy overloads and short circuits. The breaker is reset by pushing the button down to its farthest position. The breaker is available in 5- to 50-amp. sizes and is built in accordance with AN specifications. It is non-trip-free and all units are equipped with luminous indicating rings.



Vibration Mounting

Hamilton Kent Mfg. Co., Kent, Ohio.

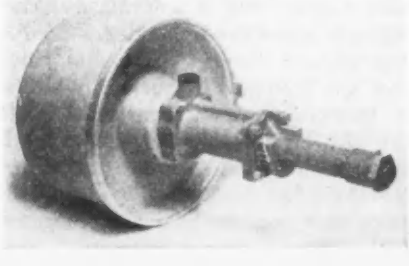
Isolation of vibration is the purpose of the Rexon mounting available in two standard variations to handle many kinds of vibration. Application data needed is the total weight, the weight distribution of the machine to be insulated, and whether the direction of the vibration is vertical or horizontal. Loading tolerance of ±10 percent in computing machine weight or weight distribution is permissible. Rexon utilizes the vibration damping properties of rubber in shear through the use of a special "X"-type rubber element that acts in shear at the points of the "X" under normal loading, but in compression when the load exceeds the rated capacity of the mount. No rubber-to-metal bonds are used. The large illustration shows the mount in detail and the three smaller views give a comparison of the mount at rest, under normal load and when overloaded, respectively. Type H is for horizontal and vertical vibrations, and Type V is for vertical vibration only. They handle dead weight loads ranging from 225 to 3,800 lb. and range in size from 7x6x2⅞ in. to 13x9½x2¹¹⁄₁₆ in.



Pressure Intensifier

Pesco Products Co., Cleveland 6, Ohio.

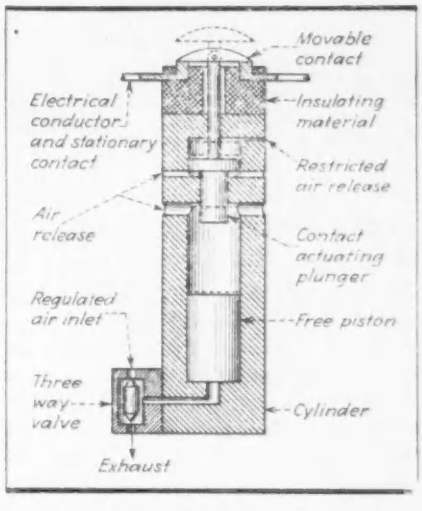
Faster braking action and lower pedal pressures on aircraft power braking systems are provided by the Univac brake intensifier. Operating in conjunction with a vacuum pump mounted on the engine, the unit produces the desired braking pressure at a pedal force of 50 lb. It is connected anywhere in the line between the master cylinder and the wheel brake and is a self-contained unit weighing 5 lb. Little piping and no levers or rods are required. The assembly consists of a vacuum-suspended piston connected to another piston in a hydraulic cylinder. When the pilot operates the master cylinder in the hydraulic brake system, thereby producing a pressure in the master cylinder to wheel brake lines, the pressure so produced shuts off the vacuum and admits air to one side of the piston. This moves the piston in the hydraulic cylinder, forcing fluid into the brake lines and increasing the line pressure. A control piston acts simultaneously with a vacuum and air valve that gives a ratio of input master cylinder pressure to brake line pressure of as high as approximately 4 to 1.



Current Interrupter

Scaiky Bros., 4915 W. 67th St., Chicago 38, Ill.

High-speed, arcless current interruption of inductive d.c. circuits is provided by the Dynatrol. It is essentially a high-speed, single-pole interrupter, the contact points of which are shunted by a bank of capacitors. The movable contacts open with high acceleration to prevent an electrical discharge while the primary current is directed to the capacitors.



Impact Molding Material

Drackett Co., 5020 Spring Grove Ave., Cincinnati 32, Ohio.

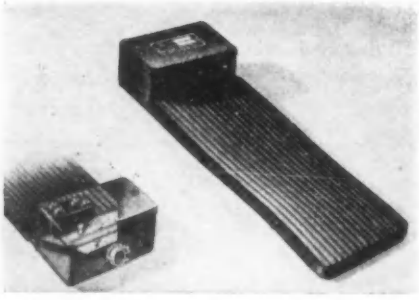
Consisting of a phenolic compound, that contains a soybean derivative, and a specially cut high-strength cotton-cord filler, a high-impact plastic material has improved molding properties. Characteristics of the material based on standard A.S.T.M. tests include tensile strength,

6,700-7,400 lb. per sq. in.; flexural strength, 10,000-14,000 lb. per sq. in.; compressive strength, 28,000-32,000 lb. per sq. in.; water absorption, 24 hr., 1.7 percent; and specific gravity, 1.41. Tendency of the resin to flow away from the filler has been reduced, increasing the ability of the material to flow through thin sections. Uniformity, moisture content, warping and shrinkage also have been brought under closer control.

Foot Switch

General Control Co., 1200 Soldiers Field Rd., Boston 34, Mass.

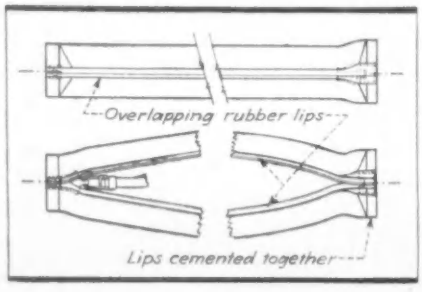
One to eight circuits can be actuated with the Model MF foot switch. The foot rest is ½ in. above the floor and the switch requires ⅞-in. throw. It is splash and dust proof and is constructed to withstand severe service.



Pressure-Sealing Closure

B. F. Goodrich Co., Akron, Ohio.

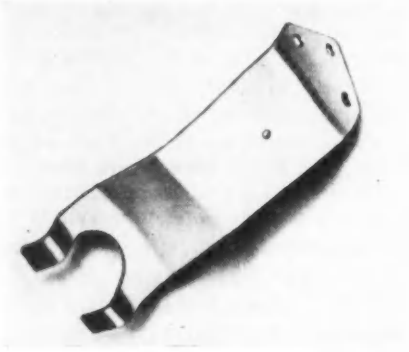
Overlapping rubber lips are used to seal slide-fastener closures against any pressure which the structural strength of the slide fastener will withstand in the pressure-sealing Zippers. The lips are placed on either side of the article to be sealed, depending on where the pressure is exerted. Used on the outside they prevent the entrance of water, air or gases. Used on the inside they prevent the escape of air, gases or liquids. Three styles are being manufactured. Two are of the non-separating type, the first sealing along its entire length but open at the top, the second sealing along its entire length and at both ends. The latter is illustrated. In the first, which is used in such applications as exposure suits, the slider is operated from either or both sides; in the second, originally developed as a closure for pressure vessels, it is operated from the side opposite the sealing lips. The third construction is of the separating type, which seals for the entire length but not at the ends, with the slider operating from either or both sides. The closure can be applied to metal, fabric or sheet rubber. Sufficient clearance must be allowed for operation of the fastener. Installation can be by stitching or cementing. The pressure seals are effective in a temperature range from —70 deg. F. to 150 deg. F.



Corrosion-Resistant Alloy

W. M. Chace Co., 1607 Beard Ave., Detroit 9, Mich.

Uniformity of heat treatment is claimed for a precipitation hardening alloy consisting of 60 percent copper, 20 percent nickel and 20 percent manganese. It is called No. 720 manganese alloy and

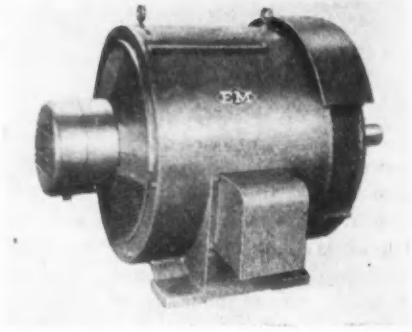


has a silvery color that presents an attractive surface when polished. It does not differ greatly from cupronickels in corrosion resistance. The alloy is a soft, ductile metal that can be either hot or cold formed into intricate shapes and then hardened to 400 Vickers or more by a relatively low temperature-aging treatment. At 400 Vickers hardness, tensile strength is 200,000 lb. per sq. in.; yield stress for 0.1 percent offset is 170,000 lb. per sq. in.; and a proportional limit is 120,000 lb. per sq. in. Because of low "drift" and high fatigue strength the alloy can be used as a spring material. Aging temperature is 750 deg. F., ±100 deg. F., and varying degrees of hardness are produced by varying the time at this temperature. Hardened parts can also be drawn to any lower hardness and rehardened. The deep-drawing characteristics and the work-hardening rate indicate uses as corrugated diaphragms, bourdon tubing and temperature- or pressure-responsive bellows. Ductility makes possible the production of corrosion-resistant forgings or upset parts that can be machined and then hardened. A stamped and hardened part is illustrated. The material is available in all forms in which stainless steel is usually supplied.

High-Speed A.C. Generators

Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Built in sizes 18.7 to 125 kva., 1,800 to 514 r.p.m., for standard voltages, 1, 2, or 3 phase, 50 and 60 cycles, 80 percent power factor, 50 or 40 deg. C. rise, a line of high-speed a.c. generators is supplied as 2-bearing units for belted or coupled duty, or single-bearing for direct coupling to driving engine. Drip-proof construction is standard. The generators are also available as "packaged" units, with controls mounted on generator frame, suitable for portable or stationary service. Controls for these units consist of a NEMA Class 1 metal enclosure housing a Synchrostat voltage regulator and meters. No switchgear is required. The generators are ventilated by a suction-type fan at the drive end of the generator which pulls air through both the direct-connected exciter and the generator. On direct-



coupled units, air is taken in at the exciter end, opposite the driving engine. Standard, direct-connected exciter is of the quill type, mounted on an extension of the generator shaft, and of drip-proof construction.

Immersion Coolant Pump

Ruthman Machinery Co., 1823 Reading Rd., Cincinnati 2, Ohio.

Available in lengths 19 in. and 23 in. immersion below the high-level line of the coolant reservoir the Gusher Model HL-15025-B deep-immersion coolant pump has a 10½-in. flange mounting that is an integral part of the unit.

The rotating assembly is on a one-piece extended steel shaft, electronically balanced after assembly, and mounted in the motor on ball bearings. There are no packing glands or metal-to-metal contacts below the high-level line. The pump has a ¼-hp. motor for continuous duty or ½-hp. motor for extra-heavy duty, in standard current characteristics.

Midget Type Relay

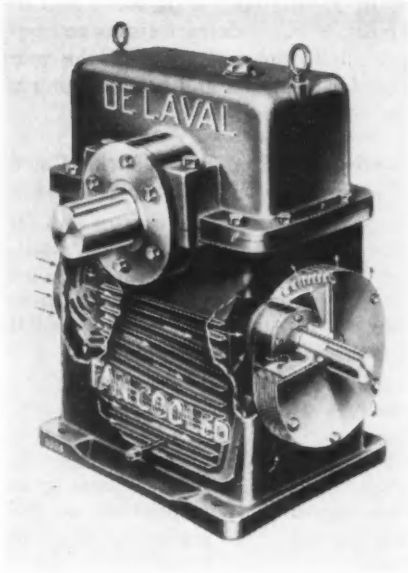
Betts & Betts Corp., 551 W. 52nd St., New York 18, N. Y.

Communications, electronics and aviation are the applications for which a midget type relay has been designed. It is hermetically sealed in a metal shell to withstand severe conditions of temperature, humidity, pressure, dust, corrosion and fungi. Units are normally sealed with content of pre-filtered dry air, but can be furnished with inert gas or pressurized content when desired. They incorporate a standard octal plug base and are 1⅛ x 2⅞ in., including prongs. Weight is 4 oz. Coil windings can be supplied for voltage ranges from 1.5 to 70 volts, d.c. Inorganic-base plastic insulation minimizes high-frequency loss. Contact arrangements handle 2 amp. at 100 watts.

Fan-Cooled Speed Reducer

DeLaval Steam Turbine Co., Trenton 2, N. J.

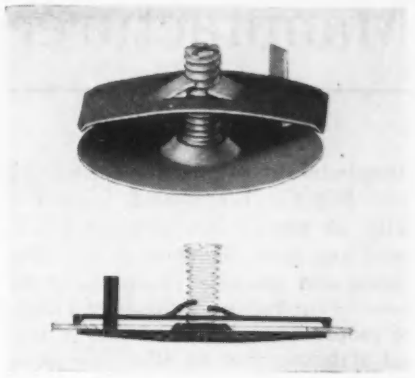
Forced-air cooling, as employed in a fan-cooled worm-gear speed reducer, increases the capacity of the gear for practically all ratios and sizes at 1,750 r.p.m. A fan mounted on the worm shaft draws air at high velocity over and around heat-dissipating ribs on the air side of the oil reservoir housing the gearing. A double wall confines the cooling air to the housing and improves heat transfer.



Cover Plates

Tinnerman Products, Inc., 2041 Fulton Rd., Cleveland 13, Ohio.

First designed for patching bullet holes in airplanes, Speed Nut cover plates are now used for removable covers for inspection doors, access holes and vent holes and to seal holes left after alterations or removal of equipment. They are attached from one side by sliding one end of the Speed Nut into the hole, centering the cover plate over the hole and tightening the screw. The turned-down tab on the cover plate prevents the Speed Nut from turning while the screw is tightened. For removal, the screw is loosened and the Speed Nut slipped out of the hole. These devices are made of SAE 1060 steel, heat treated, Parkerized and coated with zinc-chromate primer. Three sizes are now available for various panel thicknesses and to cover holes 29/32, 1⅛ and 1⅜ in. in diameter.



Constant-Level Lubricator

Oil-Rite Corp., 3482 S. 13th St., Milwaukee 7, Wis.

Consisting of two basic parts, the Style B constant-level oiler has a base that has bottom and side outlets, either or both of which can be used for bearing feed. Large air vents can be connected to a filter or to a breather tube on the bearing. Oil level is clearly marked on the outside. A thumbscrew permits removal of reservoir for refilling. The reservoir is sealed to a collar with a new type of plastic cement, providing a 50-percent stronger bond than on earlier models, which is resistant to oil, water, heat or acid. A spring stopper prevents spilling of oil when filling. These lubricators are available in five sizes with capacities of 1, 2, 4, 8, and 16 oz.

Manufacturers' Publications

Aluminum Castings—Monarch Aluminum Mfg. Co., Cleveland 2, Ohio. Bulletin, 16 pages. Die, permanent-mold, sand and zinc die castings are illustrated and described from the standpoint of product possibilities and tables of properties and compositions of typical aluminum casting alloys are given.

Electrical Controls—Switch & Panel Div., Square D Co., 6060 Rivard St., Detroit 11, Mich. Digest No. 129, 76 pages. Lists and illustrates various switches, circuit breakers, panelboards and other equipment not described in previous digests.

Plastic Coatings — Roxalin Flexible Finishes, Inc., Elizabeth F, N. J. Book, 44 pages. Types of plastics and their outstanding properties as surface coatings are thoroughly covered.

Aluminum-Alloy Parts — Harvey Machine Co., 6200 Avalon Blvd., Los Angeles 3, Calif. Booklet, 20 pages. Numerous screw-machine parts made of dural are illustrated.

Couplings—Aircraft Accessories Div., Thompson Products, Inc., Cleveland, Ohio. Bulletin, 24 pages. Various models of quick-disconnect couplings for lines that handle different types of fluids are shown and performance data are given.

Stress Relief—Brush Div., Osborn Mfg. Co., 5401 Hamilton Ave., Cleveland, Ohio. Discusses relieving stress concentration by means of power brushing.

Steel Castings—Lebanon Steel Foundry, Lebanon, Pa. Reference Chart, 4 pages. Gives nominal analyses and minimum physical properties of carbon and low-alloy cast steels.

Tube Parts—Wolverine Tube Div., Calumet & Hecla Consolidated Copper Co., Detroit 9, Mich. Bulletin, 32 pages. Typical parts fabricated from copper, brass and aluminum tubing are illustrated and manufacturing operations are described to enable choice of most economical method.

Control—Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Catalog N-OOA(2), 24 pages. Describes duration-adjusting controls for regulating heat input of electrically heated units.

Pumps—Lyon-Raymond Corp., Greene, N. Y. Bulletin 138, 4 pages. Foot and hand-operated hydraulic pumps are shown and specifications are given.

Springs—Reliable Spring & Wire Forms Co., 3167 Fulton Rd., Cleveland 9, Ohio. Catalog 44, 16 pages. Wide variety of springs of various groups is illustrated and extensive spring data are presented.

Wire—Rockbestos Products Corp., New Haven 4, Conn. Bulletin 53-A, 24 pages. Covers detailed properties and characteristics of flame-resistant wire for aircraft applications.

Steel Castings—American Steel Castings Co., Ave L & Herbert St., Newark 1, N. J. Bulletin, 4 pages. Gives analyses, physical characteristics and typical applications of some of the more popular corrosion and heat-resisting alloy steels.

Corrosion—International Nickel Co., 67 Wall St., New York 5, N. Y. Booklet, 52 pages. Corrosion processes and factors that influence their action, testing methods that stimulate service conditions and applicability of Monel, nickel and Inconel in various corrosive media are analyzed and reviewed.

Product Development—Designers for Industry, Inc., 2915 Detroit Ave., Cleveland 13, Ohio. Flow Chart. Enables planning of six basic steps in the development of new products so they will be ready for marketing when desired.

Leather Belting—Graton & Knight Co., 356 Franklin St., Worcester 4, Mass. Manual, 56 pages. Selection and application of leather transmission belting are covered in detail.

Screw-Thread Fits—Service Literature Dept., Greenfield Tap & Die Corp., Greenfield, Mass. Booklet, 40 pages. Specification data on each size of thread from No. 3 machine screw through 1 in. in NC and NF series are presented.

Plastics—Celanese Plastics Corp., 180 Madison Ave., New York 16, N. Y. Booklet, 12 pages. Properties and characteristics of cellulose plastics are listed and numerous illustrations show typical application to indicate possible future civilian uses for these materials.

Hydraulics—Hydraulic Div., New York Air Brake Co., 420 Lexington Ave., New York, 17, N. Y. Bulletin, 15 pages. Types of medium- and high-pressure hydraulic systems for precise control of power transmission are covered in text, charts and line drawings.

V-Belts—B. F. Goodrich Co., Akron, Ohio. Handbook, 74 pages. Advantages, selection, installation and maintenance of V-belts for industrial applications are fully discussed.

Metal Hose — Chicago Metal Hose Corp., Maywood, Ill. Pamphlet, 12 pages. Basic types and principal specifications of flexible metal hose are given.

Plastic Coatings—Plastic Lining Corp., 914 S. Wabash Ave., Chicago 5, Ill. Bulletin, 16 pages. Covers characteristics, limitations, application and performance of Line-Tite plastic coatings.

Laboratory Supplies — Corning Glass Works, Corning, N. Y. Catalog LP24, 168 pages. Illustrates and gives detailed data on Pyrex and Vycor laboratory glassware, including tubing and rod.

Chemical Storage — Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. Bulletin No. 7.427-B, 24 pages. Information developed under a chemical storage fellowship at the Mellon Institute covers physical properties pertinent to the storage of a number of commercially important liquids and gases.

Fittings—Bowser, Inc., Fort Wayne, Ind. Bulletin, 4 pages. Various tank fittings, quick-detachable couplings, hose nozzles, valves and hose are described and illustrated.

Air Cylinder—Airop, Inc., 12841 Ford Rd., Dearborn, Mich. Folder, 6 pages. Application photographs, range of installations, principal features and constructional drawings of the company's air cylinder are presented.

Industrial Greases—E. F. Houghton & Co., 240 W. Lehigh St., Philadelphia, Pa. Bulletin, 12 pages. Technical factors involved in the lubrication of machinery, including selection of the lubricant, and descriptions of general types of industrial greases are given.

Powdered-Iron Cores—Henry L. Crowley & Co., 1 Central Ave., West Orange, N. J. Bulletin, 36 pages. Basic engineering information is given about the functions and applications of powdered-iron cores for electronic equipment.

Porcelain Enamel—Porcelain Enamel Institute, Washington 5, D. C. Folder, 8 pages. Advantages, limitations, design application considerations and uses for porcelain enamel are covered.

Polar Moments of Inertia of Circles

F. E. REED, JR., *and* A. H. MASON

Marine Engineers, U. S. Maritime Commission

THE accompanying table of area polar moments of inertia of circles has been calculated principally to facilitate computations involving stresses and torsional stiffnesses in rotating shafting and moments of inertia of flywheels. The headings of the table are

D = dia. of circle, in.;

AK^2 = area of circle, sq. in., multiplied by the square of the polar radius of gyration.

Examples of the use of the data in such problems are:

1. Required the shear stress in a 17⅞ in. dia. steel shaft transmitting 20,000 hp. at 120 r.p.m.

The torque M in the shaft

$$= \frac{63{,}025 \times \text{hp.}}{\text{r.p.m.}} = 10{,}504{,}000 \text{ in. lb.}$$

Shear stress $S = Mr/I$

From the table the polar moment of inertia I of a 17⅞ in. diameter circle is 10,023 in.⁴

The shear stress then becomes

$$S = \frac{10{,}504{,}000 \times 17.875}{10{,}023 \times 2} = 9{,}366 \text{ lb. per sq. in.}$$

2. Required the torsional stiffness of a section of steel shafting 15⅝ in. in diameter and 240 in. in length.

$C = GI/L$

G = Modulus of rigidity = 11.8×10^6 lb. per sq. in.

I = 5851.7 from table.

$$C = \frac{11.8 \times 10^6 \times 5851.7}{240} = 287.7 \times 10^6 \text{ in. lb. per radian}$$

3. Required the moment of inertia of the annulus of a steel flywheel of 72½ in. exterior diameter, 56⅜ in. interior diameter and 6 in. thickness.

By use of the table the required value becomes

$I = (2{,}712{,}400 - 991{,}620) \times 0.284 \times 6$

$= 1{,}720{,}780 \times 0.284 \times 6$

$= 2{,}932{,}000$ lb. in.²

D	AK^2	D	AK^2	D	AK^2	D	AK^2	D	AK^2	D	AK^2
0.125	0.00002397	5.750	107.32	11.500	1,717.1	17.250	8,692.7	23.000	27,473	28.500	64,771
0.250	0.00038350	5.875	116.96	11.625	1,793.0	17.375	8,947.5	23.125	28,075	28.625	65,915
0.375	0.0019414			11.750	1,871.3			23.250	28,687	28.750	67,073
		6.000	127.23	11.875	1,952.2	17.500	9,207.7	23.375	29,309	28.875	68,247
0.500	0.0061359	6.125	138.17			17.625	9,473.6				
0.625	0.014980	6.250	149.80	12.000	2,035.8	17.750	9,745.1	23.500	29,941	29.000	69,437
0.750	0.031063	6.375	162.15	12.125	2,121.9	17.875	10,023	23.625	30,583	29.125	70,641
0.875	0.057548			12.250	2,210.8			23.750	31,236	29.250	71,862
		6.500	175.25	12.375	2,302.4	18.000	10,306	23.875	31,899	29.375	73,099
1.000	0.098175	6.625	189.12			18.125	10,595				
1.125	0.15726	6.750	203.81	12.500	2,396.8	18.250	10,890	24.000	32,572	29.500	74,351
1.250	0.23968	6.875	219.33	12.625	2,494.2	18.375	11,192	24.125	33,256	29.625	75,619
1.375	0.35092			12.750	2,594.4			24.250	33,950	29.750	76,904
		7.000	235.72	12.875	2,697.7	18.500	11,500	24.375	34,656	29.875	78,205
1.500	0.49701	7.125	253.01			18.625	11,814				
1.625	0.68456	7.250	271.24	13.000	2,804.0	18.750	12,134	24.500	35,372	30.000	79,522
1.750	0.92077	7.375	290.44	13.125	2,913.4	18.875	12,461	24.625	36,100	30.125	80,855
1.875	1.2134			13.250	3,026.0			24.750	36,838	30.250	82,205
		7.500	310.63	13.375	3,141.8	19.000	12,794	24.875	37,589	30.375	83,573
2.000	1.5708	7.625	331.86			19.125	13,134				
2.125	2.0023	7.750	354.17	13.500	3,260.9	19.250	13,481	25.000	38,350	30.500	84,957
2.250	2.5168	7.875	377.57	13.625	3,383.3	19.375	13,835	25.125	39,122	30.625	86,358
2.375	3.1232			13.750	3,509.2			25.250	39,907	30.750	87,777
		8.000	402.12	13.875	3,638.6	19.500	14,195	25.375	40,703	30.875	89,212
2.500	3.8339	8.125	427.85			19.625	14,563				
2.625	4.6624	8.250	454.80	14.000	3,771.5	19.750	14,937	25.500	41,511	31.000	90,667
2.750	5.6155	8.375	482.99	14.125	3,908.0	19.875	15,319	25.625	42,331	31.125	92,137
2.875	6.7074			14.250	4,048.2			25.750	43,163	31.250	93,626
		8.500	512.48	14.375	4,192.1	20.000	15,708	25.875	44,007	31.375	95,134
3.000	7.9522	8.625	543.30			20.125	16,104				
3.125	9.3627	8.750	575.48	14.500	4,339.8	20.250	16,508	26.000	44,864	31.500	96,659
3.250	10.954	8.875	609.08	14.625	4,491.4	20.375	16,920	26.125	45,733	31.625	98,202
3.375	12.738			14.750	4,646.9			26.250	46,614	31.750	99,764
		9.000	644.12	14.875	4,806.5	20.500	17,339	26.375	47,508	31.875	101,350
3.500	14.732	9.125	680.66			20.625	17,766				
3.625	16.952	9.250	718.73	15.000	4,970.1	20.750	18,200	26.500	48,415	32.000	102,940
3.750	19.415	9.375	758.38	15.125	5,137.9	20.875	18,643	26.625	49,335	32.125	104,560
3.875	22.135			15.250	5,309.8			26.750	50,268	32.250	106,200
		9.500	799.64	15.375	5,486.1	21.000	19,093	26.875	51,215	32.375	107,850
4.000	25.133	9.625	842.56			21.125	19,552				
4.125	28.425	9.750	887.19	15.500	5,666.7	21.250	20,018	27.000	52,174	32.500	109,530
4.250	32.030	9.875	933.58	15.625	5,851.7	21.375	20,494	27.125	53,147	32.625	111,220
4.375	35.968			15.750	6,041.2			27.250	54,133	32.750	112,940
		10.000	981.75	15.875	6,235.3	21.500	20,978	27.375	55,134	32.875	114,670
4.500	40.258	10.125	1,031.8			21.625	21,470				
4.625	44.921	10.250	1,083.7	16.000	6,434.0	21.750	21,970	27.500	56,148	33.000	116,430
4.750	49.978	10.375	1,137.5	16.125	6,637.4	21.875	22,480	27.625	57,175	33.125	118,200
4.875	55.450			16.250	6,845.7			27.750	58,217	33.250	120,000
		10.500	1,193.3	16.375	7,058.7	22.000	22,998	27.875	59,274	33.375	121,810
5.000	61.359	10.625	1,251.2			22.125	23,526				
5.125	67.729	10.750	1,311.1	16.500	7,276.7	22.250	24,061	28.000	60,344	33.500	123,650
5.250	74.583	10.875	1,373.1	16.625	7,499.8	22.375	24,607	28.125	61,429	33.625	125,500
5.375	81.943			16.750	7,727.9			28.250	62,528	33.750	127,380
		11.000	1,437.4	16.875	7,961.2	22.500	25,161	28.375	63,642	33.875	129,280
5.500	89.836	11.125	1,503.8			22.625	25,725				
5.625	98.286	11.250	1,572.6	17.000	8,199.7	22.750	26,298				
		11.375	1,643.6	17.125	8,443.5	22.875	26,881				

(Continued on next page)

Polar Moments of Inertia of Circles (continued)

D	AK²	D	AK²	D	AK²	D	AK²	D	AK²	D	AK²
34.000	131,190	45.000	402,580	56.000	965,470	67.000	1,978,100	78.000	3,633,900	89.000	6,159,700
34.125	133,140	45.125	407,070	56.125	974,140	67.125	1,993,100	78.125	3,657,300	89.125	6,194,300
34.250	135,100	45.250	411,610	56.250	982,840	67.250	2,008,000	78.250	3,680,700	89.250	6,229,100
34.375	137,080	45.375	416,150	56.375	991,620	67.375	2,022,900	78.375	3,704,300	89.375	6,264,200
34.500	139,080	45.500	420,780	56.500	1,000,400	67.500	2,038,000	78.500	3,728,000	89.500	6,299,200
34.625	141,110	45.625	425,410	56.625	1,009,300	67.625	2,053,200	78.625	3,751,700	89.625	6,334,500
34.750	143,160	45.750	430,100	56.750	1,018,300	67.750	2,068,400	78.750	3,775,700	89.750	6,369,900
34.875	145,230	45.875	434,820	56.875	1,027,300	67.875	2,083,700	78.875	3,799,700	89.875	6,405,500
35.000	147,320	46.000	439,570	57.000	1,036,300	68.000	2,099,100	79.000	3,823,900	90.000	6,441,200
35.125	149,440	46.125	444,360	57.125	1,045,500	68.125	2,114,600	79.125	3,848,100	90.125	6,477,100
35.250	151,580	46.250	449,200	57.250	1,054,600	68.250	2,130,100	79.250	3,872,500	90.250	6,513,000
35.375	153,740	46.375	454,080	57.375	1,063,900	68.375	2,145,800	79.375	3,897,000	90.375	6,549,300
35.500	155,920	46.500	458,990	57.500	1,073,200	68.500	2,161,500	79.500	3,921,600	90.500	6,585,500
35.625	158,130	46.625	463,960	57.625	1,082,500	68.625	2,177,300	79.625	3,946,300	90.625	6,622,000
35.750	160,360	46.750	468,940	57.750	1,092,000	68.750	2,193,300	79.750	3,971,200	90.750	6,658,600
35.875	162,620	46.875	473,980	57.875	1,101,400	68.875	2,209,200	79.875	3,996,200	90.875	6,695,300
36.000	164,900	47.000	479,060	58.000	1,111,000	69.000	2,225,400	80.000	4,021,200	91.000	6,732,300
36.125	167,200	47.125	484,180	58.125	1,120,600	69.125	2,241,500	80.125	4,046,400	91.125	6,769,400
36.250	169,520	47.250	489,350	58.250	1,130,300	69.250	2,257,800	80.250	4,071,700	91.250	6,806,600
36.375	171,870	47.375	494,520	58.375	1,140,000	69.375	2,274,100	80.375	4,097,100	91.375	6,843,900
36.500	174,250	47.500	499,790	58.500	1,149,800	69.500	2,290,600	80.500	4,122,700	91.500	6,881,400
36.625	176,650	47.625	505,060	58.625	1,159,600	69.625	2,307,100	80.625	4,148,300	91.625	6,919,100
36.750	179,070	47.750	510,390	58.750	1,169,600	69.750	2,323,700	80.750	4,174,100	91.750	6,957,000
36.875	181,520	47.875	515,730	58.875	1,179,600	69.875	2,340,400	80.875	4,200,000	91.875	6,995,000
37.000	184,000	48.000	521,160	59.000	1,189,600	70.000	2,357,200	81.000	4,226,100	92.000	7,033,100
37.125	186,490	48.125	526,600	59.125	1,199,700	70.125	2,374,100	81.125	4,252,200	92.125	7,071,400
37.250	189,020	48.250	532,110	59.250	1,209,900	70.250	2,391,000	81.250	4,278,500	92.250	7,109,900
37.375	191,570	48.375	537,620	59.375	1,220,100	70.375	2,408,100	81.375	4,304,800	92.375	7,148,500
37.500	194,140	48.500	543,220	59.500	1,230,500	70.500	2,425,200	81.500	4,331,400	92.500	7,187,300
37.625	196,750	48.625	548,830	59.625	1,240,800	70.625	2,442,500	81.625	4,358,000	92.625	7,226,200
37.750	199,370	48.750	554,480	59.750	1,251,300	70.750	2,459,900	81.750	4,384,800	92.750	7,265,200
37.875	202,030	48.875	560,190	59.875	1,261,800	70.875	2,477,300	81.875	4,411,600	92.875	7,304,600
38.000	204,710	49.000	565,960	60.000	1,272,300	71.000	2,494,800	82.000	4,438,600	93.000	7,343,900
38.125	207,420	49.125	571,760	60.125	1,283,000	71.125	2,512,400	82.125	4,465,700	93.125	7,383,500
38.250	210,150	49.250	577,590	60.250	1,293,700	71.250	2,530,100	82.250	4,493,000	93.250	7,423,200
38.375	212,910	49.375	583,480	60.375	1,304,500	71.375	2,547,900	82.375	4,520,400	93.375	7,464,100
38.500	215,700	49.500	589,410	60.500	1,315,300	71.500	2,565,800	82.500	4,547,900	93.500	7,503,100
38.625	218,510	49.625	595,390	60.625	1,326,200	71.625	2,583,800	82.625	4,575,500	93.625	7,543,300
38.750	221,350	49.750	601,410	60.750	1,337,200	71.750	2,601,900	82.750	4,603,300	93.750	7,583,700
38.875	224,220	49.875	607,480	60.875	1,348,200	71.875	2,620,100	82.875	4,631,100	93.875	7,624,200
39.000	227,120	50.000	613,590	61.000	1,359,300	72.000	2,638,300	83.000	4,659,200	94.000	7,665,000
39.125	230,050	50.125	619,710	61.125	1,370,500	72.125	2,656,700	83.125	4,687,300	94.125	7,705,700
39.250	233,000	50.250	625,960	61.250	1,381,700	72.250	2,675,200	83.250	4,715,600	94.250	7,746,800
39.375	235,980	50.375	632,220	61.375	1,393,000	72.375	2,693,700	83.375	4,743,900	94.375	7,788,000
39.500	238,990	50.500	638,520	61.500	1,404,400	72.500	2,712,400	83.500	4,772,500	94.500	7,829,500
39.625	242,030	50.625	644,850	61.625	1,415,900	72.625	2,731,100	83.625	4,801,100	94.625	7,870,900
39.750	245,100	50.750	651,230	61.750	1,427,400	72.750	2,750,000	83.750	4,829,800	94.750	7,912,500
39.875	248,200	50.875	657,680	61.875	1,439,000	72.875	2,769,000	83.875	4,858,800	94.875	7,954,400
40.000	251,330	51.000	664,170	62.000	1,450,700	73.000	2,788,000	84.000	4,887,800	95.000	7,996,300
40.125	254,490	51.125	670,690	62.125	1,462,400	73.125	2,807,100	84.125	4,917,000	95.125	8,038,500
40.250	257,670	51.250	677,290	62.250	1,474,200	73.250	2,826,400	84.250	4,946,300	95.250	8,080,900
40.375	260,890	51.375	683,930	62.375	1,486,100	73.375	2,845,700	84.375	4,975,700	95.375	8,123,400
40.500	264,130	51.500	690,610	62.500	1,498,000	73.500	2,865,200	84.500	5,005,200	95.500	8,166,000
40.625	267,410	51.625	697,330	62.625	1,510,100	73.625	2,884,700	84.625	5,034,900	95.625	8,208,900
40.750	270,710	51.750	704,110	62.750	1,522,200	73.750	2,904,300	84.750	5,064,800	95.750	8,251,900
40.875	274,050	51.875	710,930	62.875	1,534,300	73.875	2,924,100	84.875	5,094,700	95.875	8,295,100
41.000	277,420	52.000	717,810	63.000	1,546,500	74.000	2,943,900	85.000	5,124,800	96.000	8,338,400
41.125	280,820	52.125	724,730	63.125	1,558,800	74.125	2,963,900	85.125	5,154,900	96.125	8,381,900
41.250	284,250	52.250	731,720	63.250	1,571,200	74.250	2,983,900	85.250	5,185,300	96.250	8,425,600
41.375	287,710	52.375	738,760	63.375	1,583,700	74.375	3,004,000	85.375	5,215,800	96.375	8,469,500
41.500	291,200	52.500	745,840	63.500	1,596,200	74.500	3,024,300	85.500	5,246,400	96.500	8,513,400
41.625	294,720	52.625	752,960	63.625	1,608,800	74.625	3,044,700	85.625	5,277,200	96.625	8,557,700
41.750	298,280	52.750	760,130	63.750	1,621,500	74.750	3,065,100	85.750	5,308,000	96.750	8,602,100
41.875	301,870	52.875	767,370	63.875	1,634,300	74.875	3,085,600	85.875	5,339,000	96.875	8,646,600
42.000	305,490	53.000	774,650	64.000	1,647,100	75.000	3,106,300	86.000	5,370,200	97.000	8,691,300
42.125	309,140	53.125	781,980	64.125	1,660,000	75.125	3,127,100	86.125	5,401,500	97.125	8,736,200
42.250	312,830	53.250	789,350	64.250	1,673,000	75.250	3,147,900	86.250	5,432,900	97.250	8,781,300
42.375	316,550	53.375	796,800	64.375	1,686,000	75.375	3,168,900	86.375	5,464,500	97.375	8,826,500
42.500	320,290	53.500	804,290	64.500	1,699,200	75.500	3,190,000	86.500	5,496,100	97.500	8,871,900
42.625	324,090	53.625	811,830	64.625	1,712,400	75.625	3,211,100	86.625	5,528,000	97.625	8,917,400
42.750	327,910	53.750	819,430	64.750	1,725,700	75.750	3,232,400	86.750	5,560,100	97.750	8,963,200
42.875	331,760	53.875	827,070	64.875	1,739,100	75.875	3,253,700	86.875	5,592,100	97.875	9,009,100
43.000	335,640	54.000	834,780	65.000	1,752,500	76.000	3,275,300	87.000	5,624,400	98.000	9,055,300
43.125	339,570	54.125	842,530	65.125	1,766,000	76.125	3,296,900	87.125	5,656,800	98.125	9,101,500
43.250	343,500	54.250	850,360	65.250	1,779,600	76.250	3,318,600	87.250	5,689,300	98.250	9,148,000
43.375	347,490	54.375	858,200	65.375	1,793,300	76.375	3,340,400	87.375	5,721,900	98.375	9,194,700
43.500	351,530	54.500	866,120	65.500	1,807,100	76.500	3,362,300	87.500	5,754,800	98.500	9,241,500
43.625	355,580	54.625	874,090	65.625	1,820,800	76.625	3,384,400	87.625	5,787,700	98.625	9,288,500
43.750	359,680	54.750	882,140	65.750	1,834,800	76.750	3,406,500	87.750	5,820,800	98.750	9,335,700
43.875	363,800	54.875	890,200	65.875	1,848,700	76.875	3,428,700	87.875	5,854,100	98.875	9,383,100
44.000	367,970	55.000	898,350	66.000	1,862,800	77.000	3,451,100	88.000	5,887,400	99.000	9,430,600
44.125	372,170	55.125	906,540	66.125	1,877,000	77.125	3,473,600	88.125	5,921,000	99.125	9,478,200
44.250	376,410	55.250	914,810	66.250	1,891,200	77.250	3,496,100	88.250	5,954,600	99.250	9,526,200
44.375	380,680	55.375	923,100	66.375	1,905,500	77.375	3,518,800	88.375	5,988,500	99.375	9,574,300
44.500	384,980	55.500	931,470	66.500	1,919,900	77.500	3,541,600	88.500	6,022,400	99.500	9,622,500
44.625	389,320	55.625	939,880	66.625	1,934,400	77.625	3,564,500	88.625	6,056,500	99.625	9,671,000
44.750	393,700	55.750	948,370	66.750	1,949,000	77.750	3,587,500	88.750	6,090,700	99.750	9,719,700
44.875	398,120	55.875	956,900	66.875	1,963,600	77.875	3,610,700	88.875	6,125,100	99.875	9,768,500
										100.000	9,817,500

Long Life

The life of a Sleeve Bearing is figured in years . . . not months. It is not unusual for us to learn of instances where Johnson Sleeve Bearings have been in continuous operation for fifteen . . . twenty . . . twenty-five years. And still delivering efficient performance.

There are several reasons why these records are possible. For instance, every Johnson bearing is made from the highest quality metal available. Every manufacturing operation is laboratory controlled. Johnson bearings are "tailor-made" to suit the application . . . to meet the operating conditions. Sleeve bearings are simple in construction . . . no moving parts within the bearing to fail.

Helping manufacturers to build real service into their product is a welcome assignment for Johnson Bronze. Simply call in a Johnson Engineer. Permit him to study your applications. Provide him with adequate information . . . speeds . . . loads . . . shock . . . or other operating conditions. He will give you the right solutions . . . based on facts . . . free from prejudice. Manufacturers giving thought to their postwar product will do well to consult with Johnson Bronze *now*.

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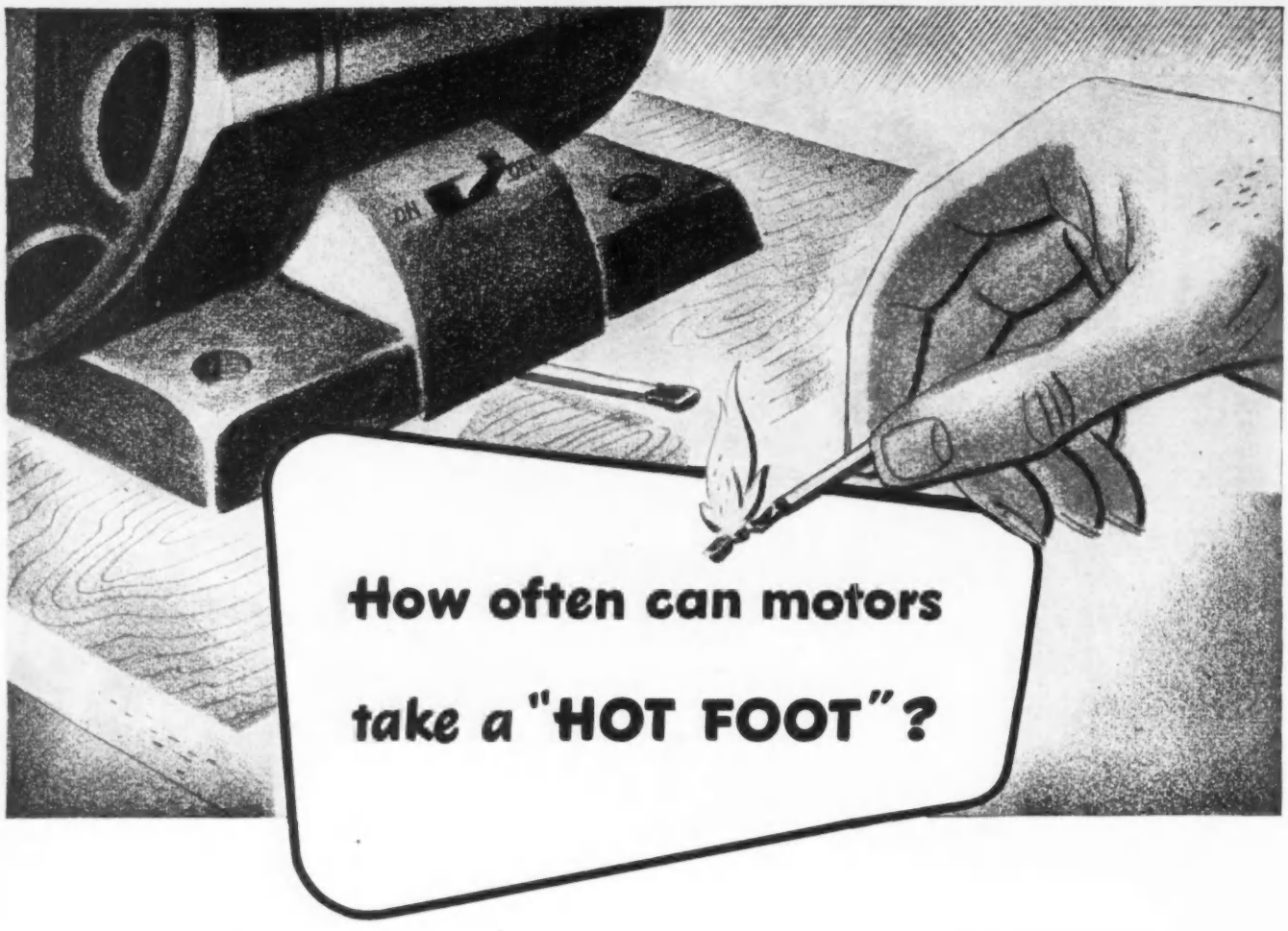

Overloads, dirt, corrosive acids, heat, moisture *and the human element* can all play tricks on even the best designed motors. Any one, or a combination of them, can give your motor a "hot foot" once too often, then — failure.

Most motors are designed, by experts, to do their specific jobs efficiently. Most of them are built to give trouble-free service and to operate economically. Without the motor manufacturers' design and production skill American industry would be at a standstill today. Yet, the records show that motor failure still imposes an extremely heavy time and dollar loss on every industry.

Fiberglas* Electrical Insulation Materials have proved their ability to protect motors of all types from the conditions which cause a majority of the failures. They provide that "extra" protection which assures longer, more economical operation and decreases down time and its consequent production losses.

Fiberglas Insulation cuts rewind shutdowns

Typical of the advantages which Fiberglas Insulation provides is this experience of a concern in the metal-working industry.

A manufacturer of automotive parts was using 3 h-p, squirrel-cage, 3600 rpm motors to drive fans for operator and hot stock cooling. The motors were operated in high ambient temperatures and exposed to dust, grit and metal scale. The motors were failing at sixty-day intervals. Operators complained and the production line was slowed down while motors were being replaced and rewound.

Then these motors were rewound with the same size and type of wire, but with Fiberglas Insulation throughout. They have been in operation for over a year, with no failures to date.

And remember, the only added cost in rewinding with Fiberglas is the slight difference in the cost of the insulating materials.

Fiberglas Electrical Insulation Materials, in plain and treated forms, are available now. For complete information consult your distributor or write for new catalog. *Owens-Corning Fiberglas Corporation, 1869 Nicholas Bldg., Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

* * *

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THE NEXT SHOWINGS ARE: Bellevue Stratford, Philadelphia, January 30-February 2; Belvedere, Baltimore, February 7-8; Hotel Roosevelt, Pittsburgh, February 19-21; Hotel Statler, Buffalo, February 27-March 1; Biltmore, Dayton, March 7-8; Netherlands Plaza, Cincinnati, March 13-15. Further showings will be announced later.

ASK FOR FIBERGLAS—IN YOUR NEXT NEW MOTOR—AND ON YOUR NEXT REWIND

FIBERGLAS *ELECTRICAL INSULATION*

*T. M. Reg. U. S. Pat. Off.

THERE'S A COMPLETE LINE OF FIBERGLAS ELECTRICAL INSULATIONS

YARNS • TAPES • CORD • SLEEVING • CLOTH AND OTHER FORMS. Also available in: Magnet wire, Lead wire, Special wires, Varnished cloth and tape; Mica Combinations: Laminates, Saturated sleeving, Varnished tubing, Pressure sensitive tapes, Special products.

Billions of $'s in Postwar Prosperity
Will Stay Locked Up... Unless We All Help to

Solve Industry's No. 1 Problem

... creating more jobs with high wages by producing *more and better products at a lower cost*

In spite of the pent-up demand created by the past few years of high earnings and restricted purchasing — John Q. Public is going to be mighty cagey when it comes to cashing in his war bonds or depleting his savings account.

The great amount of publicity given to the development of new products has sold future buyers on the fact that American industry and genius will soon deliver better, new products at a lower cost. And, having done without this long, John Q. Public is going to "wait and see."

Realizing this fact, leading manufacturers of production and processing equipment are modernizing their designs with every determination of helping to solve this vital No. 1 problem of all industry.

Business leaders know that only through soundly stimulated demand can they create increased production — and provide more jobs with high wages.

Century Motors Help to Reflect Lower Costs

Of course, machine tools and other processing equipment will play an important part in building and maintaining postwar prosperity — but electric motors are production tools, too, because they are a component part of the machines they drive.

Century Motors offer specialized advantages such as — a wide variety of motor types to match the functional characteristics of production operation—unusual freedom from vibration that contributes to closer tolerances in high speed, precision production—motor protection features that mean uninterrupted production in spite of hazardous atmospheres—permanently quiet operation that results in less waste of human energy—and many other specialized features that reflect lower final costs.

Century's Organization Helps, Too

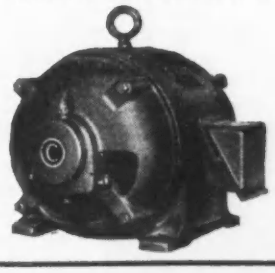
Century's national organization of Motor Specialists has long helped appliance manufacturers and machine tool builders to effect savings in original design and in production output costs. They can help you best when your machines or your products are still in the blueprint or experimental stage.

Everyone Benefits from Century's Performance

Whether you are a manufacturer of consumer products or industrial equipment, a wholesaler or retailer—you, too, have a direct or indirect stake in how well Century Motors can help others in solving the problem of delivering a better product at a lower cost.

Act Now — If you are a manufacturer of Motorized Equipment or Appliances, it will pay you to call your nearest of Century's 31 branch offices.

Century C MOTORS



409

CENTURY ELECTRIC COMPANY • 1806 Pine Street, St. Louis 3, Missouri

Offices and Stock Points in Principal Cities

RAYTHEON VOLTAGE STABILIZERS

CONTROL VARYING LINE VOLTAGES

TO 115 VOLTS ± ½%

Ordinary A.C. line voltages as taken from supply mains often vary as much as from 95 to 130 volts. This impairs the precision operation of electrical equipment.

A Raytheon Voltage Stabilizer, built into new products or incorporated into equipment already in use, overcomes the disadvantage of fluctuating voltages by providing an accurately controlled source of power to ±½%.

Here's what a Raytheon Stabilizer does—stabilizes varying input voltage from 95 to 130 volts to 115 volts ±½% within 2 cycles.

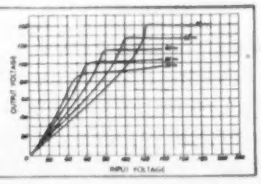
Raytheon Voltage Stabilizers are entirely automatic. They require no adjustments or repeated maintenance. No moving parts assure long life. Write for bulletin DL 48–537.

EFFECT OF VARIABLE FREQUENCY

Since partial resonance is a requisite design feature, these devices are sensitive to frequency changes. The output voltage will vary in the same direction and 1.4 times the percentage change in frequency, over a range of 5% of the normal frequency.

Stabilization, however, will be within ±½% at the output voltage which is established by the frequency.

TYPE VR 2
INPUT VS OUTPUT VOLTAGE
FOR VARIOUS FREQUENCIES



Tune in the Raytheon radio program: "MEET YOUR NAVY," every Saturday night on the Blue Network. Consult your local newspaper for time and station

RAYTHEON
MANUFACTURING COMPANY
Electrical Equipment Division
190 WILLOW STREET, WALTHAM, MASS.

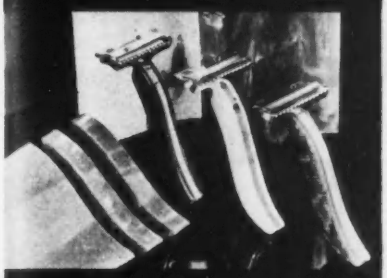
The coveted Army-Navy "E," for Excellence in the manufacture of war equipment and tubes, flies over all four Raytheon Plants where over 16,000 men and women are producing for VICTORY.

Devoted to research and manufacture of complete electronic equipment; receiving, transmitting and hearing aid tubes; transformers; and voltage stabilizers.

Catalin

REG U S PAT OFF

PLASTICS

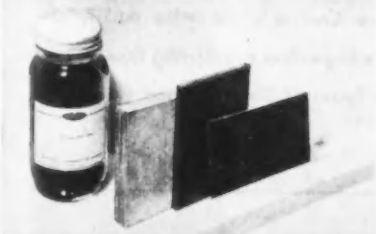


Cast Resins

Catalin and Prystal thermosetting cast phenolics offer two important advantages to designers and manufacturers . . . a range and depth of gem-like colors, equalled only by minerals and semi-precious stones . . . and casting techniques which permit the use of inexpensive, quickly constructed molds with neither size nor thickness limitations. The properties of Catalin and Prystal are worth investigation.

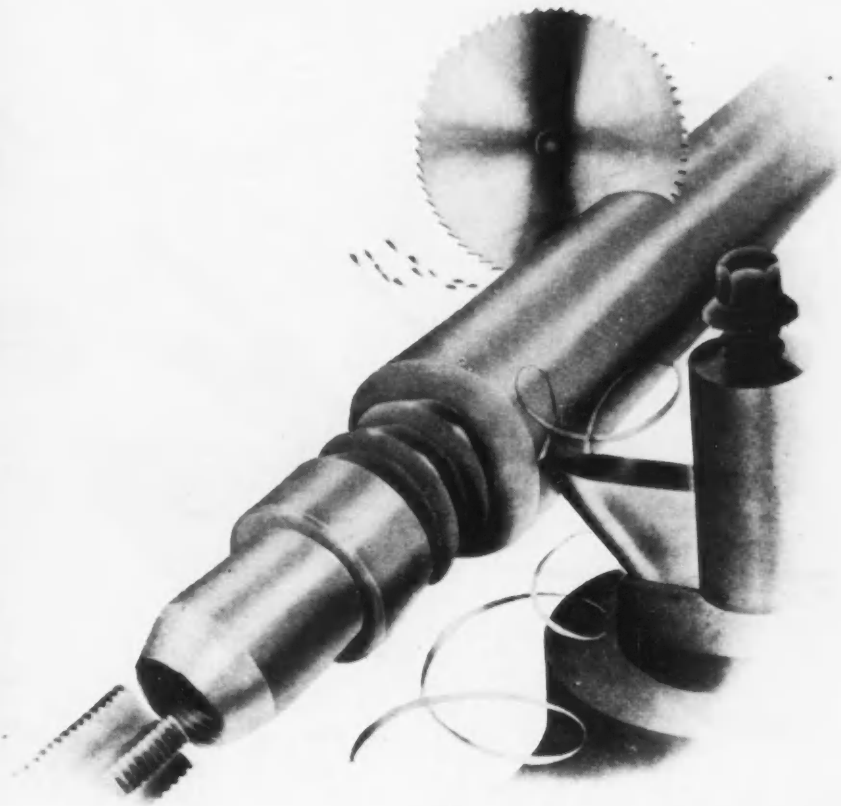
Molding Compounds

"Loalin" polystyrene thermoplastic injection molding compounds enjoy a unique position among plastics. It possesses outstanding electrical, chemical and mechanical properties. It has a "zero" water absorption and is unrivalled in dimensional stability. Loalin is the lightest weight of all the plastics and one of the least costly. It is available in a limitless range of brilliant colors.



Liquid Resins

Catabond, Catavar and Loaband identify a wide variety of liquid resin formulations employed for coating, laminating, glueing, impregnating and bonding wood, plywood, abrasives, paper, cork, brake linings, brushes, etc. Several of these formulations now make possible low-cost techniques for the fabrication of aluminum sheets. They can be economically cast at your own plant and excel as drill and saw jigs, router, shaper and hydroform blocks; checking fixtures, stretch press molds and dies.



machinability

"Catalin . . . An insoluble, infusible, cast phenolic resin of gem-like beauty and an unlimited color range — which in forms of rods, tubes, sheets or shapes can be machined on ordinary shop equipment as easily as wood or brass."

This descriptive announcement made in 1927 marked *Catalin's* opening bid for the attention of industry . . . and it is to this degree of unexcelled machinability that *Catalin* in no small measure owes its acceptance and growth!

Catalin could be turned at high speeds without coolants . . . Machining operations such as drilling, tapping, threading, carving, sanding, sawing and shaping, instantly revealed ease of handling . . . Men who had worked wood and brass, and fabricators familiar with all materials, found in *Catalin* the perfect medium for all machining operations . . . Furthermore, extremely close tolerances could be maintained on large production runs—and at low cost! *Catalin* was indeed "The Gem of Plastics".

Broad acceptance brought further development. Today, *Catalin's* casting processes give free rein to product designers. Special shapes of any size or thickness can now be cast to exacting specifications—in fractions of the time and cost required for molding — and with a minimum of finishing fabrication.

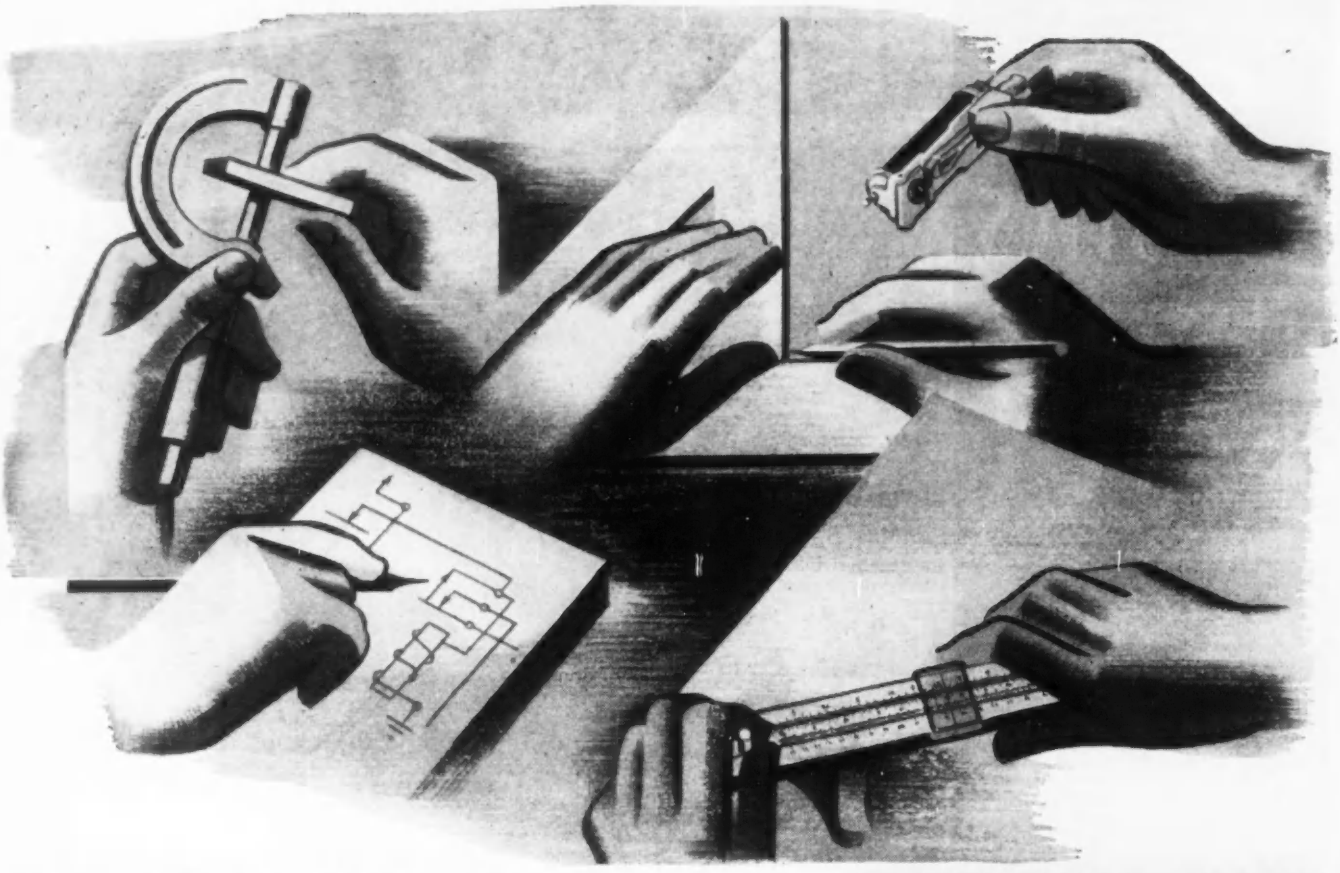
It is these *Catalin* facilities of ease in handling that will also mean most to tomorrow's planners. The quick reconversion of enormously expanded fabricating machinery will be calling for materials of greatest beauty—available in sufficient volume to enable their manufacturers to be first to market with the first products of a free world. You can count upon *Catalin* cast resins to fill that most important role . . . and as this peace dawns and restrictions fade, you can also depend upon *Loalin* polystyrene molding and extruding compounds — and *Catabond* and *Catavar* Liquid Resins to supply the tremendous and waiting needs of all industry.

Catalin

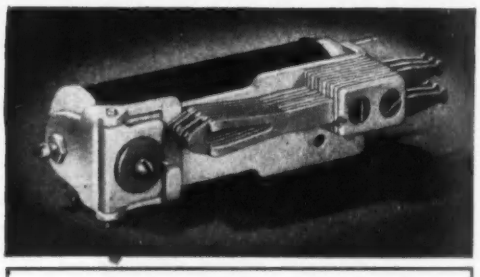
Cast Resins
Molding Compounds
Liquid Resins

CATALIN CORPORATION

ONE PARK AVENUE • NEW YORK 16, N. Y.



Your New Product may need the Magic of Electrical Control



TAKE another look at that new product your designers are planning. It may be that Automatic Electric control devices can make it function better—at lower cost. It's worth checking into.

To help designers perfect new developments—or improve old ones—Automatic Electric offers this unique three-point service:

1. Technical advice by experienced field engineers, who know the "how" and "why" of control technique.
2. A complete range of relays, stepping switches, and other control units—time-proved products readily adapted to your needs.
3. A design and manufacturing service for complete engineered assemblies.

Ask our field engineer for a copy of our catalog of control devices. He will be glad to show you how they can serve you.

Here are jobs that can be done easier and better with Automatic Electric control devices:

Automatic Selection and Switching of Circuits • Time, Temperature and Sequence Control • Counting and Totalizing • Inspection and Sorting Operations • All Types of Electrical and Electronic Control.

Relays
AND OTHER CONTROL DEVICES
by **AUTOMATIC ELECTRIC**

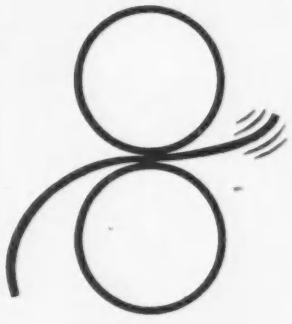
AUTOMATIC ELECTRIC SALES CORPORATION
1033 West Van Buren Street • Chicago 7, Illinois

In Canada: Automatic Electric (Canada) Limited, Toronto

PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

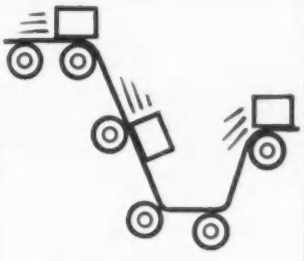
How many in YOUR BUSINESS?

Two questions: (1) how many of these ten simplified operations are important in your business? (2) how many could be handled faster, better, at lower cost—*with temperature controlled* by application of air conditioning, refrigeration or heating equipment?

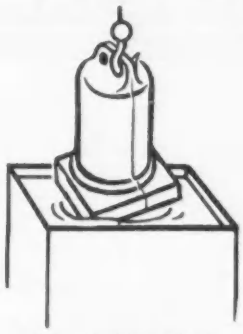


ROLL

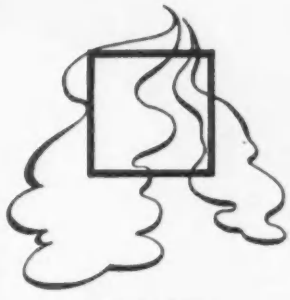
CUT



CONVEY

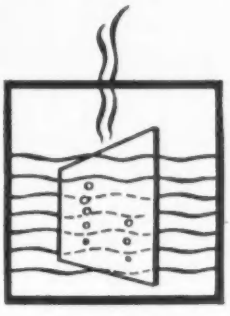


QUENCH

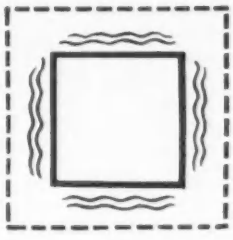


WASH

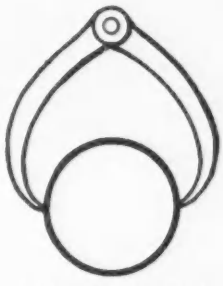
STORE



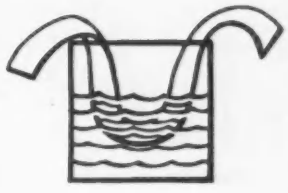
PLATE



SHRINK



MEASURE



DRY

If the problem involves HEATING or COOLING

. . . get the advice of General Electric *now*, by writing *General Electric Co., Air Conditioning and Commercial Refrigeration Divisions, Section 452, Bloomfield, N. J.*

☆ BUY . . . and hold . . . WAR BONDS ☆

INDUSTRIAL REFRIGERATION
AND AIR CONDITIONING

GENERAL ELECTRIC

Tune in: "The G-E HOUSE PARTY," every afternoon Monday through Friday, 4 p. m., E W T, C B S . . . "The G-E ALL-GIRL ORCHESTRA," Sundays 10 p. m., E W T, N B C . . . "THE WORLD TODAY," News, Monday through Friday, 6:45 p. m., E W T, C B S

This Governor-Controlled Oster Motor

Gives You the New Design and Operating Advantages of CONSTANT SPEED

Here is a new Oster development in a constant speed, governor-controlled motor that backs up your good judgment when you specify it for applications where constant speed is a necessity. This motor is now in production and deliveries can be made in the very near future. Here are the features that assure you of satisfaction:

Housing: Die cast aluminum end brackets. Mild steel field housing. Totally enclosed.

Finish: Black anodized end brackets. Cadmium plated field housing.

Weight: 15 Oz.

Bearings: Single shielded ball bearings, lubricated with a grease suitable for any specific application. Bearing housings fitted with steel inserts.

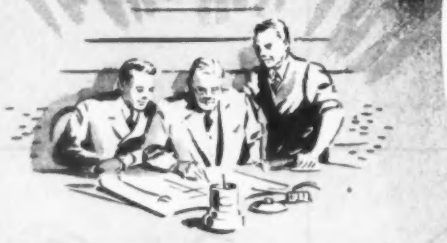
Windings & Insulation: Field coils and armature wound with a select grade of insulated copper wire and impregnated with a high quality heat and moisture resisting insulating varnish.

Brushes: Equipped with high grade metal graphite brushes. Beryllium copper brush springs.

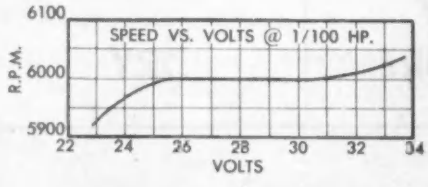
Governor: Furnished with a centrifugal governor to maintain constant speed over a voltage range of 25 to 30 volts.

Temperature Rise: Maximum frame temperature rise at rated output will not exceed 55° C.

Modifications: Motors can be furnished with special shaft extensions, mounting arrangements, finishes, leads, etc. All modified units are considered special.



When designing your post-war product, consider this new Oster development in applications where constant speed is a nesessity...



Rating of Motor Type BSTG-1A-2

Horsepower—1/100 continuous duty

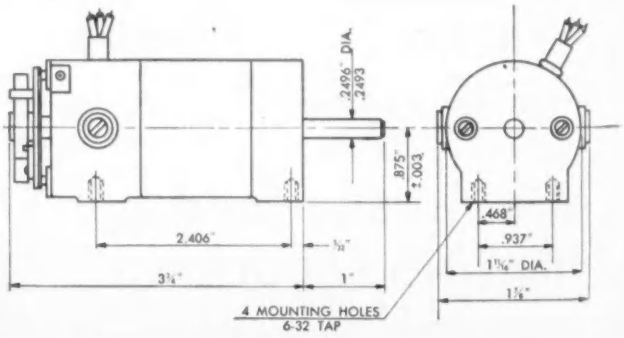
Speed—6000 R.P.M. ± 1%

Voltage—25-30 volts D.C.

Amps. input—.95

Starting Torque—300% of full load torque

• • •



Oster FRACTIONAL H.P. ELECTRIC MOTORS

Let us help you fit this and other Oster Motors to your requirements.

M-22

John Oster Manufacturing Co.

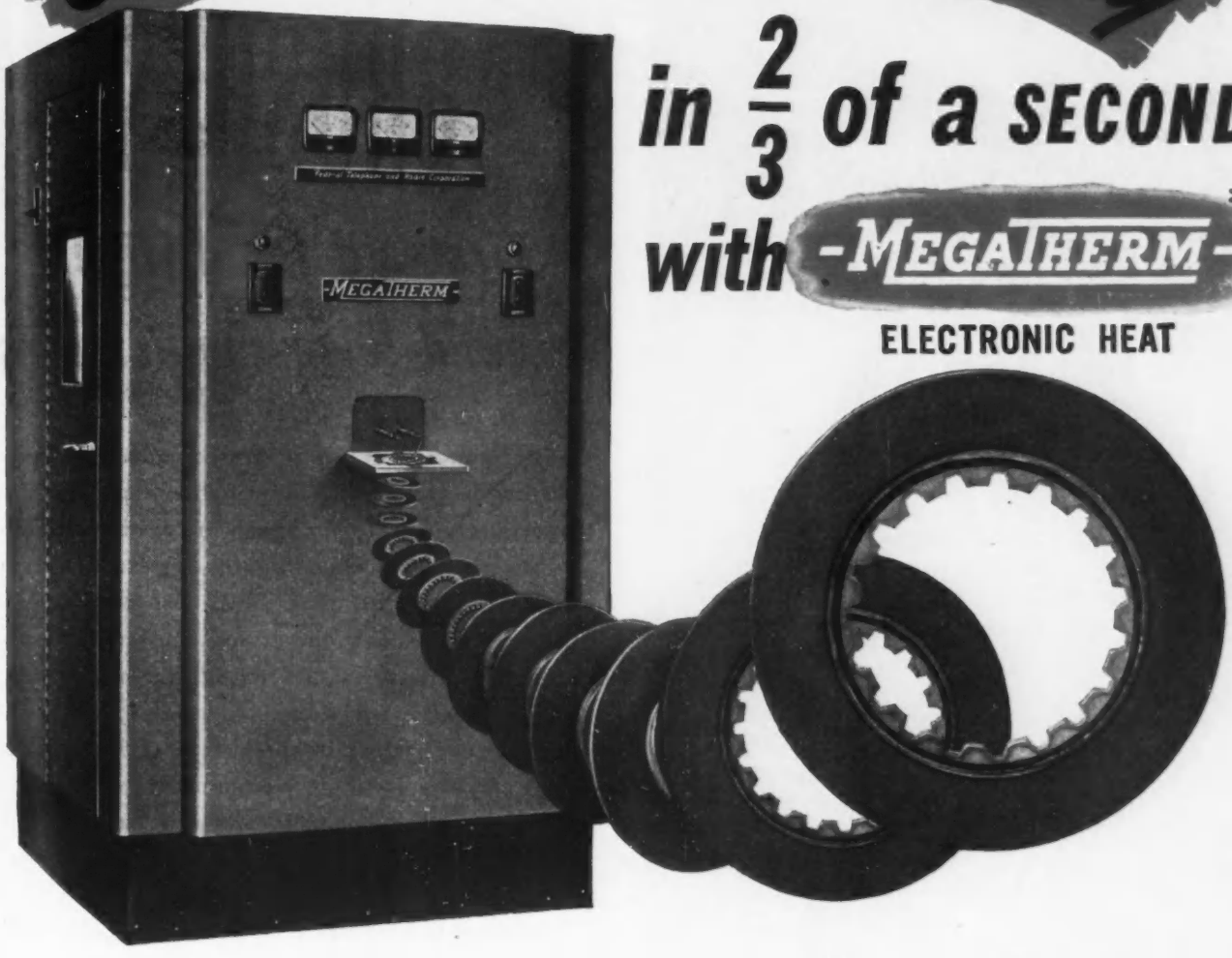
DEPARTMENT P-22 • RACINE, WISCONSIN

Exact Contour Hardening

in 2/3 of a SECOND

with -MEGATHERM-*

ELECTRONIC HEAT



Here's another difficult hardening job, done simply and quickly with Megatherm.

Exact contour hardening of the inner gear of these supercharger clutch discs was done in less than ⅔ of a second each.

These gears were hardened to a depth of .050", with the hardening closely following the tooth and root contour of the gear surface, without affecting the strength or ductility of the remaining metal. The unretouched photograph above tells the story.

To do this contour hardening a jig was built to support the disc so that its inner surface surrounded a two-turn induction coil, directly connected to the output terminals of the 25 kw Megatherm.

The Megatherm automatic timer limits the heat period to exactly ⅔ of a second, then operates a solenoid which trips the disc into an oil-quench bath.

Here is another example of Megatherm's adaptability to many hardening problems involving irregular and "hard-to-get-at" surfaces.

If you have a surface hardening problem . . . whether for wartime or peacetime application . . . consult Federal's Megatherm engineers for the answer or write for complete data.

FEDERAL TELEPHONE & RADIO — FTR

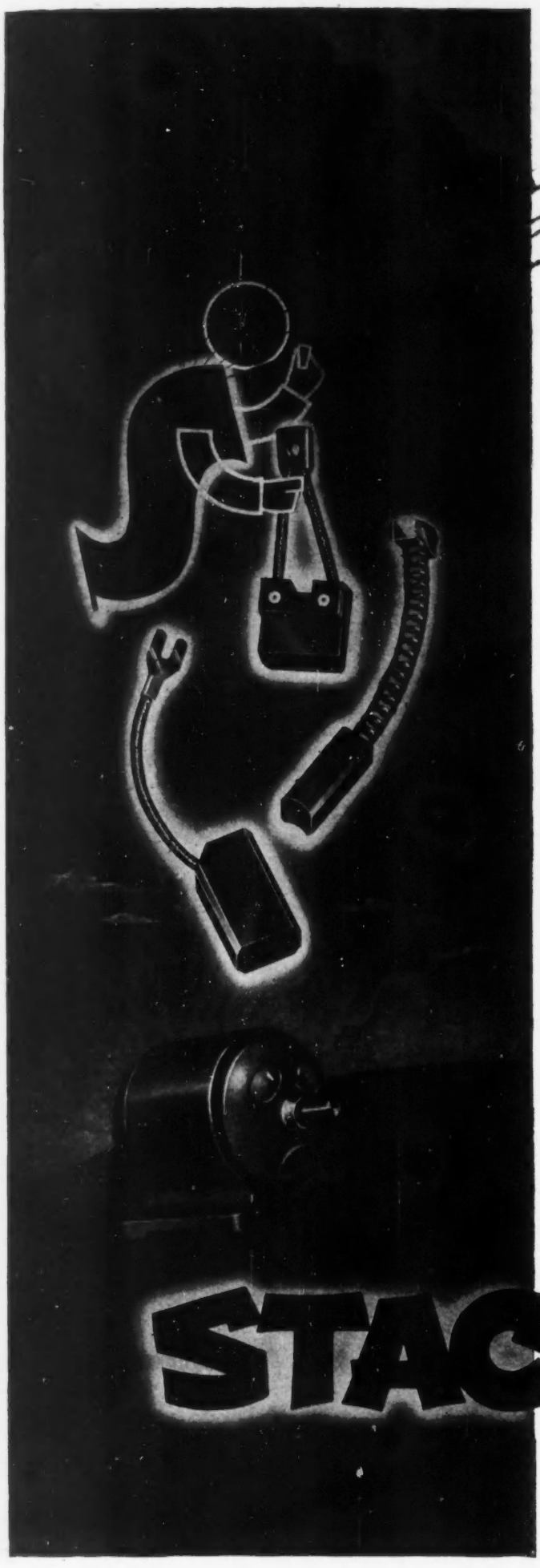
Federal Telephone and Radio Corporation

*REG. U.S. PAT. TRADE MARK

INDUSTRIAL ELECTRONICS DIVISION

AN IT&T ASSOCIATE

Newark 1, N. J.



HIGH-ALTITUDE BRUSHES...

First aid for difficult ground-level applications

Many months have now passed since Stackpole brushes treated with a Westinghouse process first made aircraft generator brush life at high altitudes a matter of weeks and months instead of simply hours. During this time, much has been accomplished in adapting these same outstanding high-altitude brush principles to difficult and unusual ground-level applications.

The basic feature of these brushes is of course their amazing ability to maintain the essential protective film on commutators in order to minimize wear under a wide variety of commutating conditions. Although Stackpole research in applying this feature to brushes for earth-surface equipment is still continuing, it has now reached a point where Stackpole engineers will welcome inquiries from brush users having unusually difficult conditions to meet. You can count on a frank and honest opinion as to whether or not we believe Stackpole High-Altitude Brushes can help you.

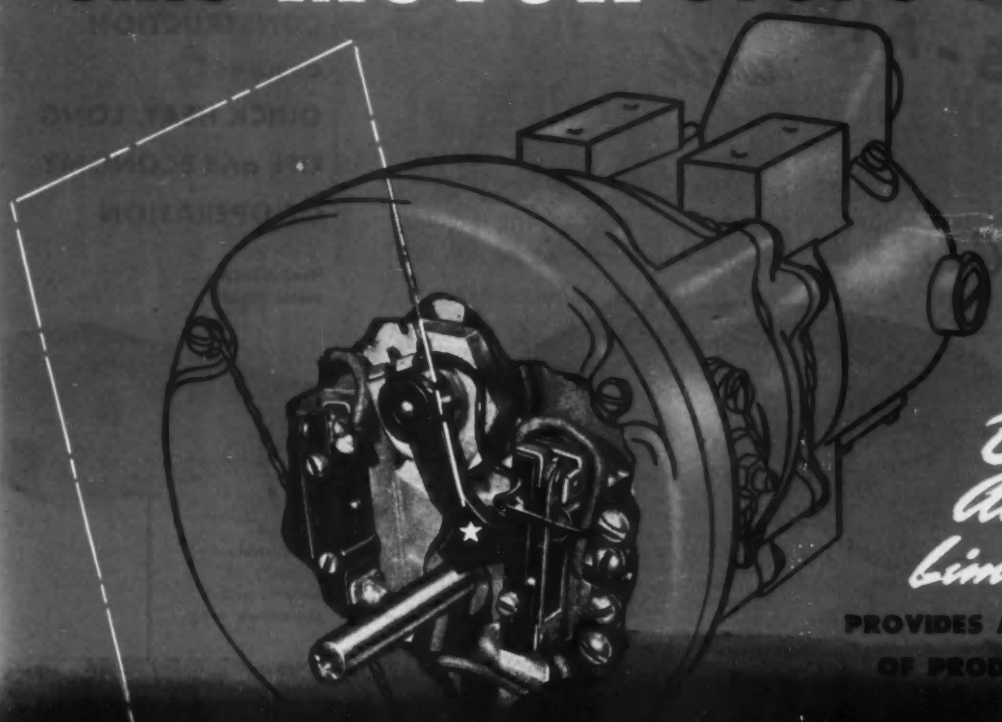
STACKPOLE CARBON CO., St. Marys, Pa.

STACKPOLE

THE NATION'S LARGEST PRODUCER OF FRACTIONAL HORSEPOWER MOTOR BRUSHES

Brushes and Contacts (All carbon, graphite, metal and composition types.) *Rare Metal Contacts • Graphite Bearings • Welding Carbon Products Packing, Piston and Seal Rings • Continuously Adjustable Carbon Rheostats Sintered Iron Components*

THIS MOTOR STOPS ITSELF!



Built-in Automatic Limit Switch

PROVIDES ACCURATE CONTROL OF PRODUCT OPERATIONS

OTHER DUMORE FEATURES

GEAR REDUCTION UNITS

MAGNETIC BRAKES

MAGNETIC CLUTCHES

OVER-RUNNING CLUTCHES

THERMAL OVERLOAD PROTECTORS

POSITION INDICATING POTENTI-OMETERS

DUMORE WILL HELP YOU ENGINEER THIS COMPACT POWER AND CONTROL UNIT INTO YOUR PRODUCT!

If your product requires — or could be made more useful or salable by — a motor which can stop itself after a certain number of revolutions, you should get in touch with Dumore engineers at once. Because Dumore has developed and produced in large volume many of the ingenious fractional h.p. motors which have contributed so greatly to the fighting power of Allied aircraft, you can expect an unusual and practical solution to your motor-design problems. Come to "Headquarters" — give your product the benefit of the most advanced thinking in motor-design and motor-production! The Dumore Company, Motor Division, Racine, Wisconsin.

IT DOES MORE BECAUSE IT'S A

DUMORE

Motor-Plan Now!

FREE! Get this helpful design data book with complete specifications on Dumore Motors. Write for your copy today!

HEADQUARTERS FOR FRACTIONAL HORSEPOWER MOTORS

HEAT SOLIDS-LIQUIDS-AIR- *with* CHROMALOX *Electric* RING HEATERS

When you heat with Chromalox you are sure

You get the ideally right heater for the job, selected from the broad line of carefully designed Chromalox heaters, widely varied in type and capacity. You get the valuable cooperation of Chromalox engineer-representatives, who *know industrial heat* and are backed up by files of valuable reference data on Chromalox past performances.

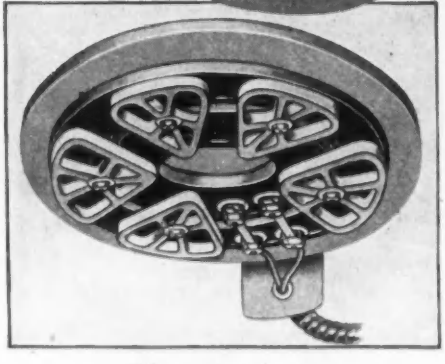
Chromalox Ring Heaters provide *uniform temperature distribution* in heating:

Machine parts, metal blocks, dies, platens, hot plates, molds . . .

Glue, oil, soft metals and other liquids . . .

Air in small ovens, incubators, brooders, etc.

Chromalox Ring Heaters assure the right heat at all times—and that means uniformly high quality product and elimination of waste. They avoid difficult mechanical problems particularly in moving dies or molds, where a simple length of flexible conduit takes the place of complicated pipes and valves. Better working conditions are yours, too, for the heat is confined to the object or area to be heated, without fumes or flame hazard.



Easy to Apply

Chromalox Ring Heaters are designed to clamp tightly to the bottom of a platen, mold or any flat surface. In the picture above Chromalox Utility Clamps are used, bolted over studs welded to the surface.

CHROMALOX CONSTRUCTION assures QUICK HEAT, LONG LIFE and ECONOMY OF OPERATION

Special CHROMALOX refractory compacted under tremendous hydraulic pressure

Study the cross-section above. Note how the surrounding refractory protects the resistance wires against exposure to air—oxidation—as well as damage by any other element. This refractory is compacted by special hydraulic presses. Its unrivalled density permits a faster rate of heat transfer which does not decrease with use.

The sheath is a further protection and its rigid die-formed design aids in maintaining the flatness of the heater's contact surface. It won't warp. All Chromalox heaters are built on this principle—responsible for the enduring high quality of Chromalox performance.

FOR MORE "KNOW HOW" ON CHROMALOX HEAT

Call in your local Chromalox Application Engineer. We will connect you. Write for catalog and literature including the "How to" book of electric heat.

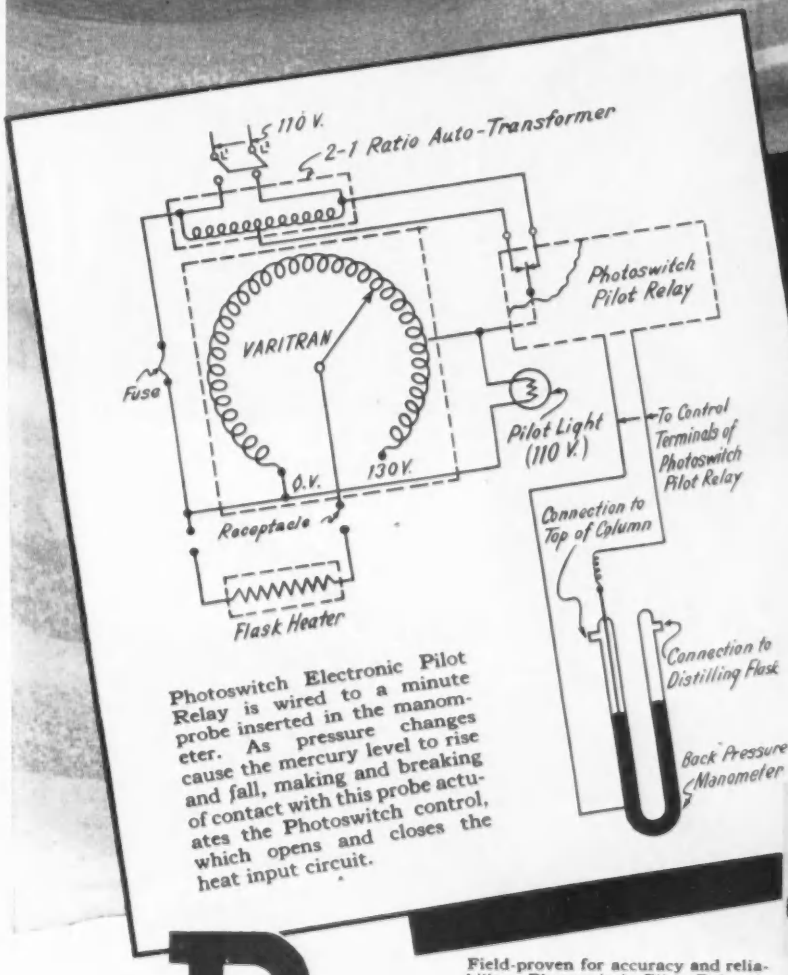
EDWIN L. WIEGAND CO.
7500 THOMAS BLVD.
PITTSBURGH 8, PA.

CHROMALOX
ELECTRIC HEAT AT ITS BEST

ELECTRONIC FINGERS *feel* THE WAY - - -

to Maintain Constant Vapor Velocity

With the aid of Photoswitch Pilot Relay, Podbielniak Centrifugal Company, manufacturer of laboratory equipment, puts electrons to work to maintain a constant vapor velocity in the distilling column of their high-temperature fractional distillation apparatus. As only microamperes are passed through the manometer fluid there is no danger of electrolysis, oxidation or explosion from sparking contacts in the presence of inflammable vapors.

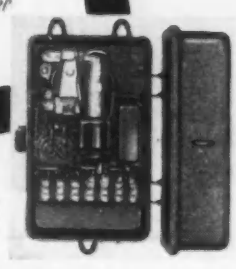


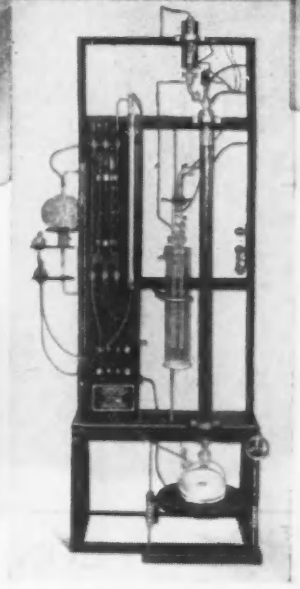
Photoswitch Electronic Pilot Relay is wired to a minute probe inserted in the manometer. As pressure changes cause the mercury level to rise and fall, making and breaking of contact with this probe actuates the Photoswitch control, which opens and closes the heat input circuit.

Photoswitch is putting electronics to work . . . today . . . controlling levels of liquids and powders; detecting concentration, contamination, turbidity, smoke and vapor density; safeguarding machines and property; counting, inspecting and routing production; timing for split-second repeat-cycle accuracy; preventing explosions in heating equipment, and maintaining boiler water levels automatically.

★ ★ ★

Photoswitch engineers are ready to work with you *now*. . . . Write to Photoswitch Incorporated at Cambridge 42, Massachusetts.





Field-proven for accuracy and reliability, Photoswitch Pilot Relay is an integral part of this precision laboratory equipment.

PHOTOSWITCH INCORPORATED

L-3

PHOTOELECTRIC AND ELECTRONIC CONTROLS FOR EVERY INDUSTRIAL PURPOSE

WHY WE LIKE TO "ROLL OUR OWN"

THE production of high-efficiency electrical and electronic equipment demands close control over the manufacture of most of the parts which go into it.

To be certain of accurate control over component parts, Connecticut Telephone and Electric Division manufactures an unusually high percentage of them in its own plant. For instance, we produce our own magnets, wind our own coils. Stampings and screw machine products are turned out to our own standards, in our own shops.

These facilities for complete fabrication of the more essential elements of a piece of electrical or electronic equipment are as important to our customers as to us—they result in a better product at a "better" price . . . also assurance of our ability to keep delivery promises.

MAGNETS have a great deal to do with the efficiency of many types of electrical apparatus. Specially developed alloys treated in our own electric furnaces permit close control over the performance of C. T. & E. products.

ARMY E NAVY

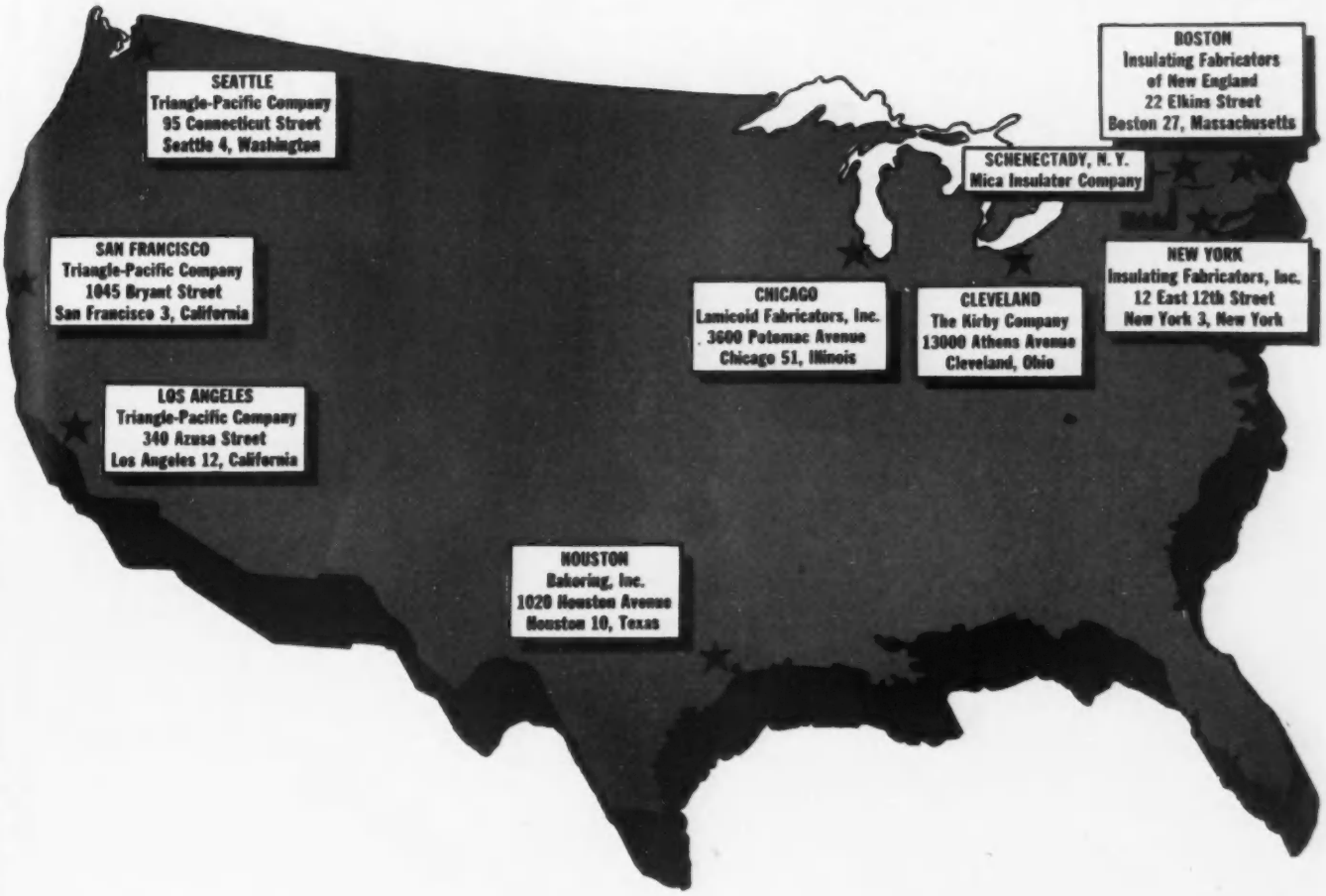
GAI

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC. • MERIDEN, CONN.

TELEPHONIC SYSTEMS • SIGNALLING EQUIPMENT • ELECTRONIC DEVICES • ELECTRICAL EQUIPMENT
HOSPITAL AND SCHOOL COMMUNICATIONS AND SIGNALLING SYSTEMS • IGNITION SYSTEMS

You're Within Easy Reach of LAMICOID



FABRICATING PLANTS LOCATED FOR FAST SERVICE

Your product—made of LAMICOID, the versatile plastic laminate—can be manufactured and delivered on short notice from our strategically located fabricating plants. These plants are located in the large industrial centers to give prompt service and quick delivery. They are fully equipped to fabricate mechanical, electrical, graphic, translucent and engraving LAMICOID products to meet your specific requirements.

There is a variety of fabric or paper bases —also asbestos or Fibreglas—laminated with the proper thermosetting resin. LAMICOID is available in rods and tubes in a wide diameter range and in sheets of 36" x 42" standard size in a range of thicknesses.

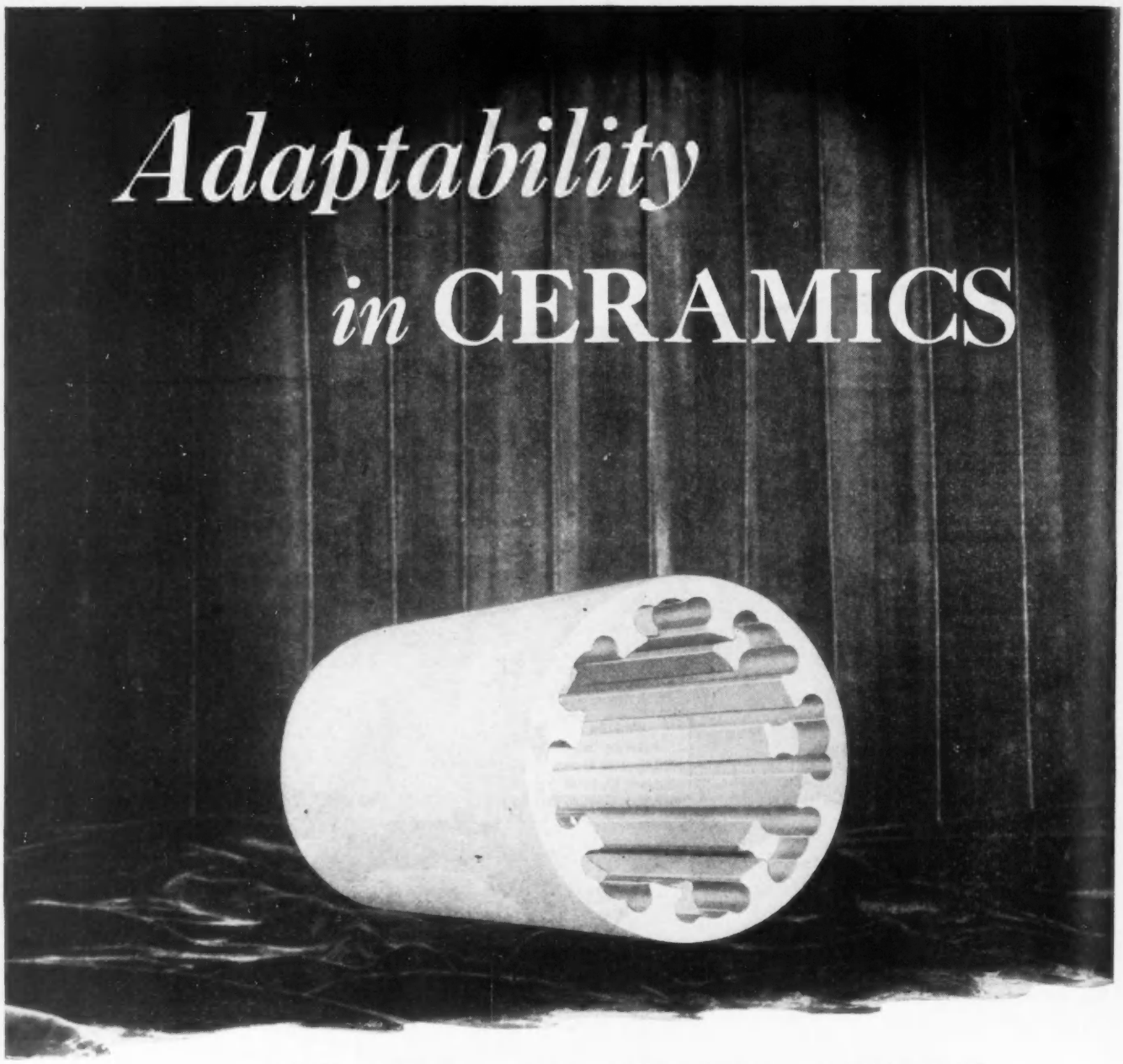
Our fabricating plants and engineering service are available to you for fitting LAMICOID to your product requirements. 'Phone or write the nearest office.

MICA INSULATOR COMPANY

200 VARICK STREET, NEW YORK 14, N. Y.

CHICAGO • DETROIT • CLEVELAND • CINCINNATI • BOSTON • HOUSTON • LOS ANGELES
SAN FRANCISCO • SEATTLE

Adaptability in CERAMICS



COIL FORM FOR INTERNAL WINDING by STUPAKOFF

Permanently strong and stable both mechanically and electrically, ceramics are versatile materials capable of intricate design. Competent engineering enables dimensional tolerances to be held to a minimum.

The internally wound coil form illustrated is engineered and produced by Stupakoff for a specific application. Resistance to thermal shock and mechanical strength are specifications embodied in this one-piece extruded insulator. Slotted, longitudinal winding holes expose the heating element and allow heat to be directed instantaneously to the center of the coil.

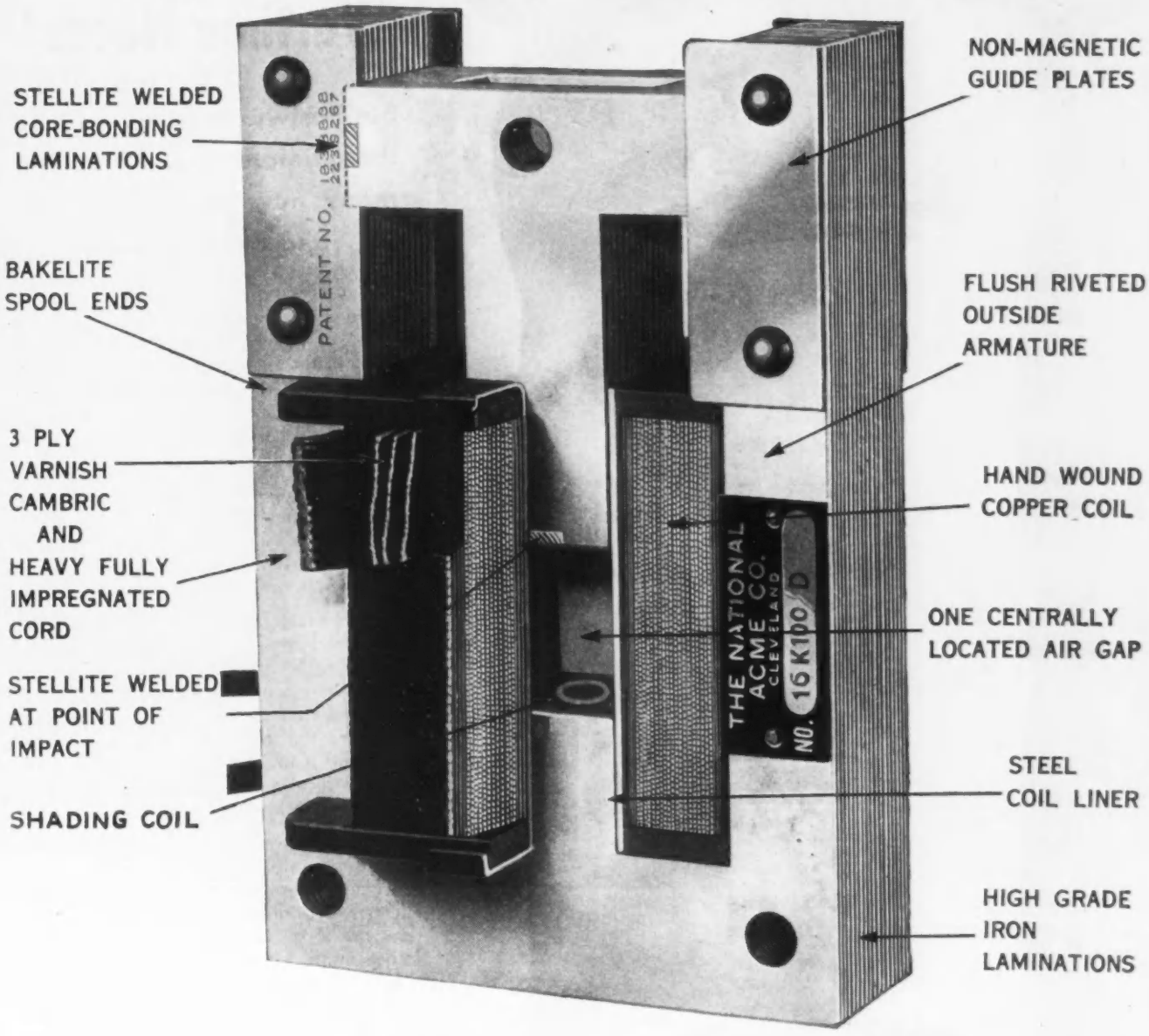
Specialists in the field of electrical insulation, Stupakoff engineers are trained to find *specific* solutions for *your* insulation problems. Contact Stupakoff today —two generations of dependability in the ceramic field justify this choice.

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Ceramics for the World of Electronics

The Only Solenoid

BUILT BY MACHINE TOOL BUILDERS FOR MACHINE TOOL BUILDERS


STELLITE WELDED CORE-BONDING LAMINATIONS
BAKELITE SPOOL ENDS
3 PLY VARNISH CAMBRIC AND HEAVY FULLY IMPREGNATED CORD
STELLITE WELDED AT POINT OF IMPACT
SHADING COIL
NON-MAGNETIC GUIDE PLATES
FLUSH RIVETED OUTSIDE ARMATURE
HAND WOUND COPPER COIL
ONE CENTRALLY LOCATED AIR GAP
STEEL COIL LINER
HIGH GRADE IRON LAMINATIONS
PATENT NO.
THE NATIONAL ACME CO. CLEVELAND
NO. 16K100 D

This "X-ray picture" shows you the special features of the Namco Solenoid.

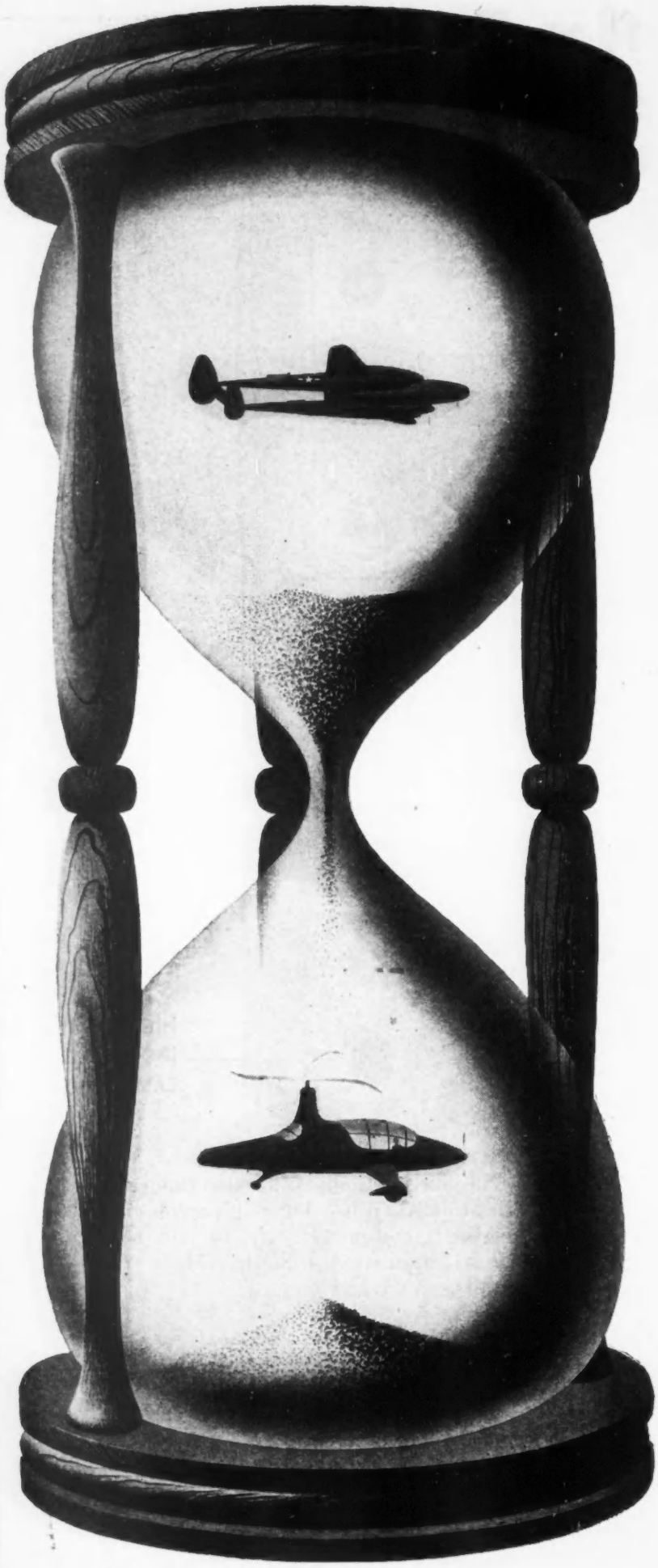
Their record in service is just what you would expect from a Solenoid so ruggedly built—so well protected against failure or wear-out.

Namco Solenoids are doing thousands of automatic jobs—let us give you engineering recommendations to suit your special application. Bulletin EM-41 gives details.

The NATIONAL ACME CO.

170 EAST 131st STREET • CLEVELAND 8, OHIO

Acme-Gridley 4-6 and 8 Spindle Bar and Chucking Automatics • Single Spindle Automatics • Automatic Threading Dies and Taps • The Chronolog • Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing



WILCO facilities Expanded to Meet Wartime Needs!

But Postwar Industry will be the ultimate gainer from the many new WILCO products and developments

As the Hourglass indicates . . . at the coming of peace, the skill and experience gained in the development and application of new WILCO products and techniques will mean much to automotive, electrical appliance and many other types of manufacturing customers.

Though now chiefly applied to the war effort, these new WILCO developments are destined to play as vital a role in the postwar industrial "comeback" as they are now playing in scores of wartime applications.

Thermostatic Bimetals, Electrical Contacts, and Precious Metal Bimetallic Products are such important factors in the precision performance of ships, planes, tanks, guns, and various instruments of the Army and Navy that the H. A. Wilson Company has found it necessary to enlarge its facilities and develop these important new products and techniques.

In the postwar period no company will be better equipped to meet individual requirements for Thermostatic Bimetals and Electrical Contacts on any desired scale than the H. A. Wilson Company, pioneers in this field.

WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel*—for bearings, shims, reflectors, *Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested. *Silver Clad Steel. Rolled Gold Plate.* Special Materials.

THE H. A. WILSON COMPANY

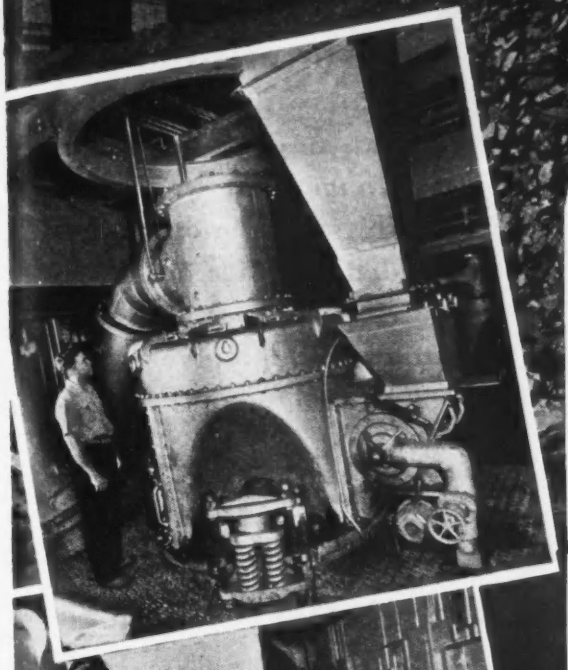
105 Chestnut Street. Newark 5, New Jersey

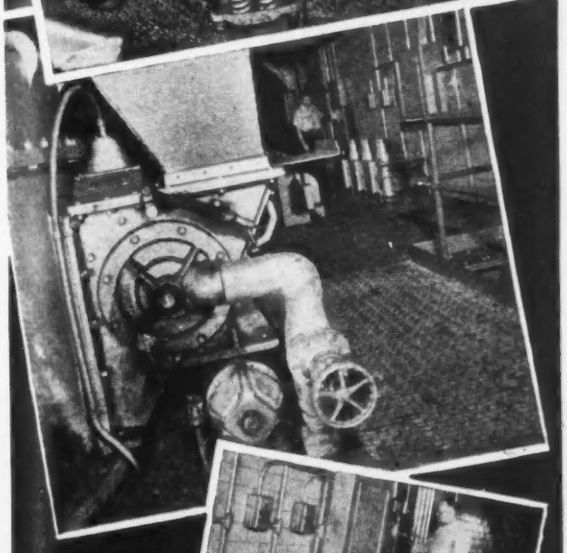
WILCO

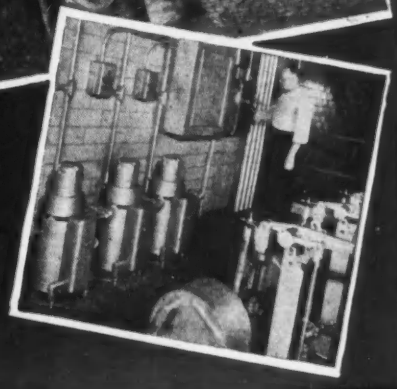
Thermometals—Electrical Contacts
Precious Metal Bimetallic Products

"MOTOR-DRIVE IS MORE THAN POWER"

RELIANCE V★S DRIVE







INVESTIGATE THE POSSIBILITIES of *All-Electric* V★S DRIVE

OPERATING FROM A-c. CIRCUITS!

CONSTANT MAINTENANCE of a desired steam pressure from boilers is important in power company operation. To you, who may not need to worry about this problem, the fact that it is being handled automatically with the help of Reliance V★S Drive should nevertheless be interesting. It is a good indication of the wide variety of uses to which V★S Drive may be put.

"Reliance V★S" is an all-electric, adjustable-speed drive for A-c. circuits that provides for starting, stopping, speed-changing, smooth acceleration and deceleration, jogging, inching and other operations. All are centrally controlled from a conveniently located panel. Production machinery output is being increased, quality and uniformity of products improved, operator fatigue decreased and operation and maintenance costs lowered by many V★S Drive applications in many industries.

If you haven't investigated Reliance V★S Drive in relation to your own work, we suggest that you call in a Reliance Application Engineer.

RELIANCE ELECTRIC & ENGINEERING CO.

1080 Ivanhoe Road • Cleveland 10, Ohio

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S. C.) • Houston
Kalamazoo • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Portland (Ore.)
St. Louis • San Francisco • Syracuse • Washington, D. C. • and other principal cities

Each of the 14-ton-per-hour mills (upper photo) serves one 500,000 pound-per-hour boiler. Amount of coal fed into each mill, and thence to its boiler, is regulated by a Reliance V★S Drive unit, three of which are shown in above illustrations.

RELIANCE A-C D-C MOTORS

THIS conversation might easily occur at our reception desk because here under one roof and management we produce both small motors and molded plastics in large quantities for use in widely different products.

YES, YOU CAN BUY *BOTH* AT GENERAL INDUSTRIES

Take small motors. We've built *Smooth Power* units for many years for our own line of velvety operating recorders, record-changers and turntables. We supply standard or designed-to-order *Smooth Power* drives and assemblies for automotive devices, controls and other small electric products. Our customers include leading manufacturers in a wide range of industries.

Now about molded plastic parts. We have the equipment for small and large work in any quantities. Our engineers, mold makers and machine operators have the combined "know-how" to deliver better plastic parts quicker and at prices in line with our established high quality. If you visit our factory (and you'll be welcome) you'll be amazed at the diversity of our work and at the length and quality of our customer list.

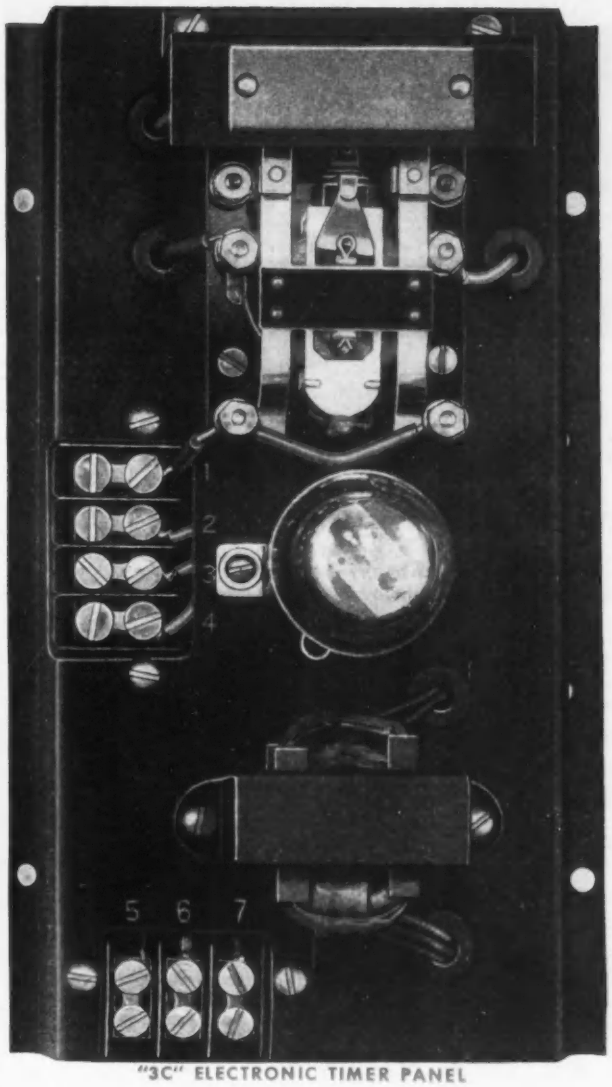
THE GENERAL INDUSTRIES COMPANY
ELYRIA, OHIO

ARMY E NAVY

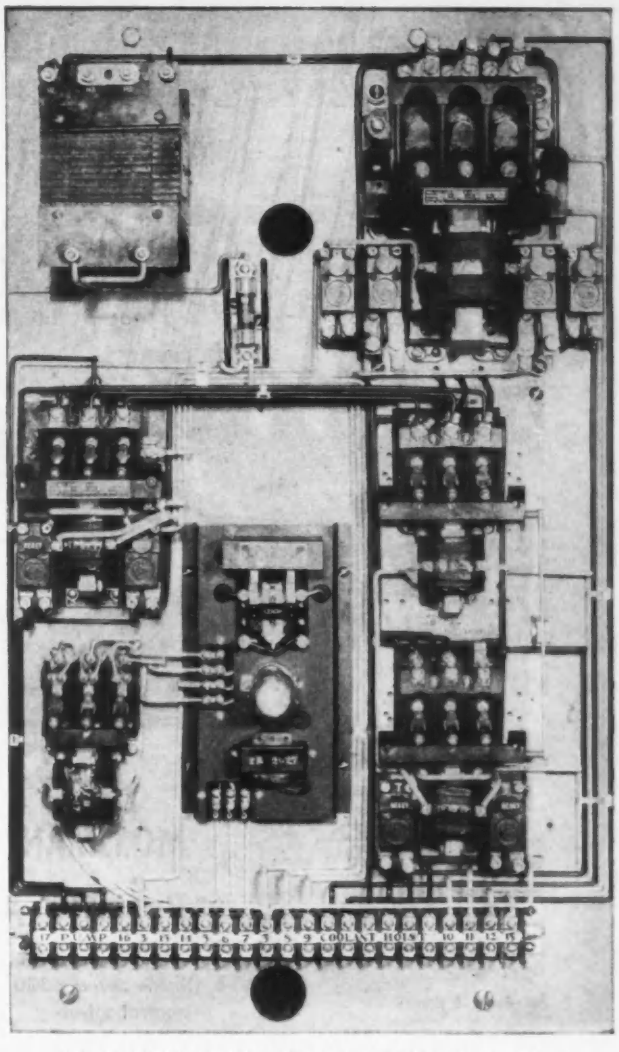
Yes, you can buy both small motors and molded plastics for your postwar products from General Industries. We suggest a general discussion now, to be followed by details when our war work has been finished. It will be appreciated if you will address the specific division . . . *motors* or *molded plastics*.

SURFACE GRINDER MAGNETIC CONTROL WITH ELECTRONIC TIMING

● The magnetic control equipment consists of individual magnetic starters providing overload and undervoltage protection for a 30 HP. spindle motor, 7½ HP. motor for hydraulic pump, 1½ HP. hoist motor, and ¾ HP. coolant pump motor. Control transformers and relays are also provided.



"3C" ELECTRONIC TIMER PANEL



"3C" CONTROL PANEL WITH ELECTRONIC TIMER

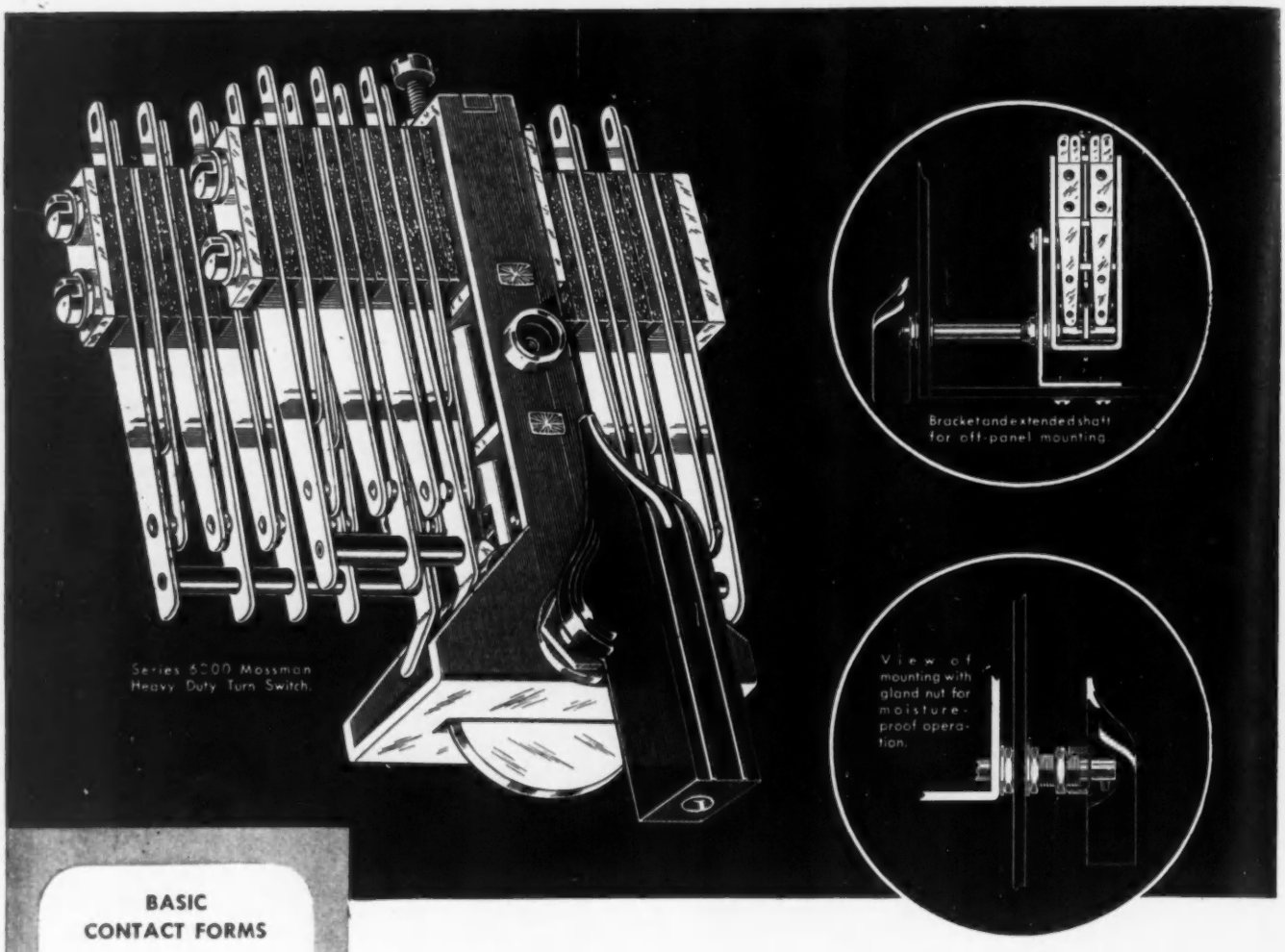
● The electronic equipment is a "3C" Bulletin 7313 type ET Electronic Timer specially designed to time the cross-feed of the grinder. Entirely automatic, it has a time range of 1/10 to 1 second, providing wheel feeds, adjustable up to width of wheel. This timer is built for a severe duty cycle —40 operations per minute, 24 hours a day.

Where quantities large enough are involved, we are in position to design similar electronic control for many involved machining operations.

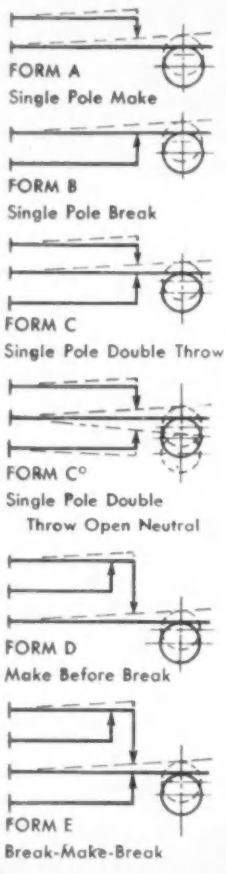
OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, 10, OHIO


Series 6300 Mossman Heavy Duty Turn Switch.
Bracket and extended shaft for off-panel mounting.
View of mounting with gland nut for moisture-proof operation.

BASIC CONTACT FORMS



MOSSMAN SERIES 6300 HEAVY DUTY TURN SWITCH

Permits Almost Unlimited Circuit Arrangements

Latest development in the Mossman line of precision heavy duty multiple circuit turn switches is the Series 6300 . . . a big, husky switch for panel mounting that permits a most versatile control set-up.

Electrical and production engineers will find this switch most useful in such applications as: Signal systems, alarm systems, controls for machine tools and welding equipment, lighting systems, annunciators and many other types of electronic devices and controls.

The Series 6300 Mossman Heavy Duty Turn Switches are available as either three position (Series 6303) or two position (Series 6302) switches. An almost unlimited series of combinations of contact assemblies may be built up by use of any combination of the six basic forms shown.

Standard heavy duty contacts are of 3/16" diameter fine silver, rated at 10 amperes, 110 volts A.C., non-inductive. Extra heavy duty contacts are of 5/16" silver alloy rated at 20 amperes, 110 volts A.C., non-inductive. Breakdown rating of springs to ground is 2000 volts, A.C.

Send for complete information on the new Series 6300 Mossman switches. Also ask for catalog which describes the full line of Mossman precision electrical components, including many types of heavy duty, multiple circuit lever switches, turn switches, push switches, plug jacks and other special switching components.

DONALD P. MOSSMAN, INC., 612 N. Michigan Ave., Chicago 11, Ill.

MOSSMAN

Electrical Components

Uniform, Synchronous Speed at Every Station

Teletype Machine powered with a Holtzer-Cabot motor

Electric motors driving the intricate mechanisms of machines that transmit and record messages verbatim must have identical operating characteristics at every station. Since standard "off-the-shelf" motors cannot meet the strict performance requirements, such as uniform, synchronous speed, quietness, load cycles, etc., the solution is a special motor designed to exactly meet the particular operating conditions.

For over 50 years Holtzer-Cabot has designed and built special motors to fit the application. Many machines such as teletype machines, and other sending and receiving equipment are Holtzer-Cabot powered.

Although, today, all of our plant facilities are being utilized for building special fractional H.P. motors for military use, our motor development engineers will gladly discuss your post-war motor requirements with you. No obligation of course.

SPECIAL MOTORS DESIGNED TO FIT THE APPLICATION

HOLTZER-CABOT

Division First Industrial Corporation

Designers and Builders of Special Fractional HP Motors and Electrical Apparatus

125 AMORY STREET, BOSTON 19, MASSACHUSETTS • CHICAGO, ILLINOIS • NEW YORK, NEW YORK • PHILADELPHIA, PENNSYLVANIA

14 MICRO SWITCHES

Control 12 Accurate Operations of this Stokes Molding Press Every 33 Seconds

Timing, limiting and safety operations of this Stokes Automatic molding press, which can perform a complete cycle in as little as 33 seconds, are accurately controlled by 14 Micro Switches.

The F. J. Stokes Machine Company of Philadelphia, Pa., turned to Micro Switch as the control components of this accurate molding machine because their small size, precise operating characteristics, long life and dependability most exactly met their requirements.

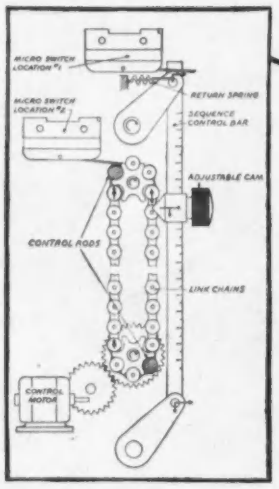
Experience of the F. J. Stokes Machine Company with Micro Switches is typical of the many uses design engineers are finding for this small, sensitive, durable, snap-action switch.

Design engineers who are planning products for the highly competitive post-war markets should be thoroughly familiar with Micro Switches and the many advantages they have to offer. We will be glad to send you as many Micro Switch Handbook-Catalogs as you may be able to use. Write for them today.

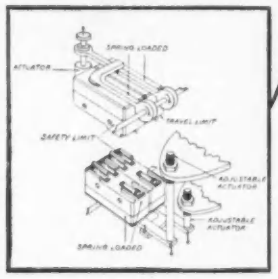
Handbook-Catalog No. 60 gives complete details on electrical characteristics, housings, and actuators.

Handbook-Catalog No. 71 gives complete information on Micro Switch for use in aircraft equipment.

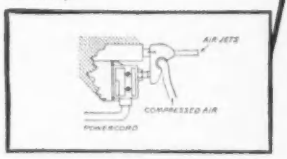
Two stars have been added to our "E" Flag as further recognition to the men and women of Micro Switch for maintaining our war production standards.



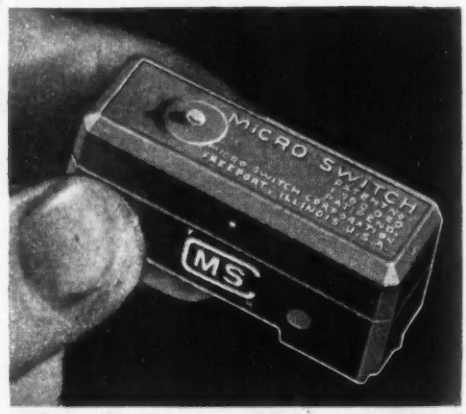
Nine Plastic Enclosed Micro Switches are used in the sequence and timer control. Eight of them are actuated by adjustable cams set along the sequence control bars. The ninth shuts off the control motor and starts the timer which determines the curing operation of the mold.



Four Plastic Enclosed Micro Switches are used—two as travel limits and two as safety limits for the press ram. The travel limits are operated by adjustable push rod actuators to stop the press ram at the correct extremes of movement. The safety limits operate only to stop the press if the others should not be set correctly.



One Die Cast Enclosed Micro Switch is used on the air and mechanical mold cleaner. It is actuated by a push rod and operates the six air jets which blow a sheet of air through the mold to blow off the molded part.



The basic Micro Switch is a thumb-size, feather-light, plastic enclosed, precision, snap-acting switch. Underwriters' listed and rated at 1200 V.A. at 125 to 460 volts a-c. Capacity on d-c depends on load characteristics. Accurate reproducibility of performance is maintained over millions of operations. Basic switches of different characteristics are combined with various actuators and metal housings to meet a wide range of requirements.

MICRO MS SWITCH

TRADE MARK

A DIVISION OF FIRST INDUSTRIAL CORPORATION

FREEPORT, ILL., U.S.A., Sales Offices in New York, Chicago, Cleveland, Los Angeles, Boston, Dallas, Portland, (Ore.)

Let's all back the attack—Buy extra War Bonds

© 1945

The Howell Protected Type Motor, shown, gives complete protection against dripping liquids, metal chips and other falling particles. Completely streamlined—utilizing non-breakable steel frame—malleable or steel base—cast iron end plates and cast iron, weatherproof terminal box are standard construction features. Special horizontal and vertical mountings are available.

Available in sizes 5 Hp. and smaller. Other sizes and types available up to 150 Hp.

Now, while the delivery situation in the entire motor industry is serious, the arrival of a new Howell Motor gives double satisfaction.

First, you get the satisfaction of receiving a better performing motor.

Second, you know that it will give you better service, because we have rigidly adhered to our policy of maintaining prewar standards and have steadfastly refused to compromise in quality.

Sure, we are swamped with orders today! But we fully recognize our obligations and are putting forth our maximum efforts to see that Howell Motors are distributed fairly among all of our customers.

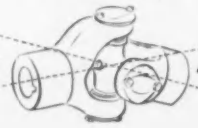
Buy Horsepower by

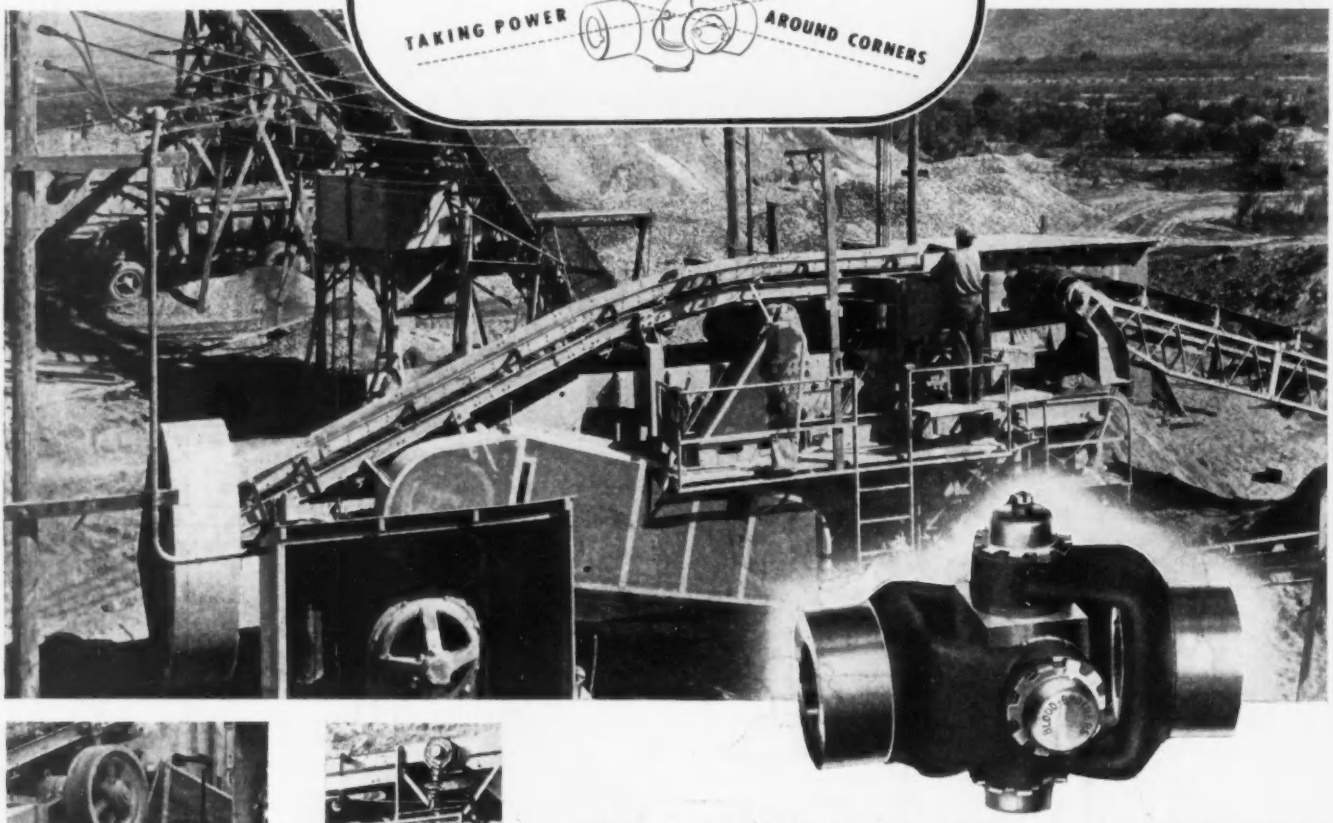
HOWELL ELECTRIC MOTORS COMPANY

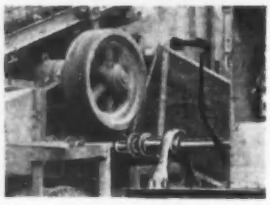
HOWELL, MICHIGAN

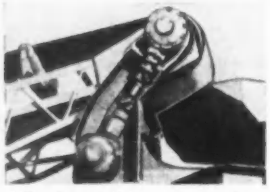
Manufacturers of Quality Motors Since 1915

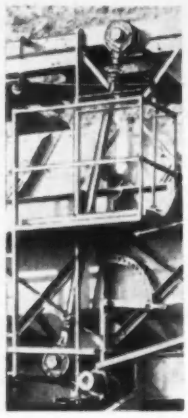
A PROBLEM IN . . .

TAKING POWER  AROUND CORNERS









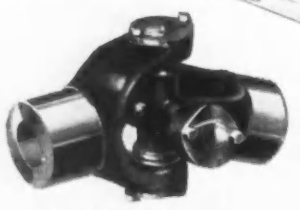
TOP: Transmitting power from unit to main countershaft.
BOTTOM: Drive from swivel head to conveyor.
RIGHT: Return conveyor power transmission.

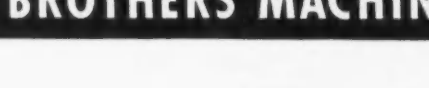
UNDER GRUELLING CONDITIONS, BLOOD BROTHERS UNIVERSAL JOINTS DELIVER THE *Power*

Where perfect alignment is impossible because of continual twisting and wearing of chassis structure, efficient power delivery is easily solved by the flexibility of universal joints. Blood universal joints are used in the giant Cedar Rapids rock crushing plant, shown above, to simplify design and help reduce cost of power, maintenance and operation. Blood joints are designed for stamina, efficient operation, economy and simplicity — backed by 30 years experience in power transmission engineering.

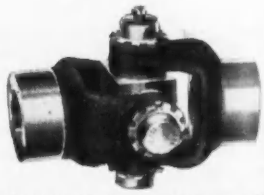
DESIGN ENGINEERS Let our engineering staff help in your design problems of transmitting power through angularity and misalignment. **FREE ENGINEERING DATA:** Specifications on all Blood Brothers universal joints and engineering bulletins — write Dept. 12.

BLOOD BROTHERS
UNIVERSAL JOINTS


AUTOMOTIVE TYPE


CONSTRUCTION EQUIPMENT TYPE

FARM EQUIPMENT TYPE


POWERED MACHINERY TYPE

BLOOD BROTHERS MACHINE CO. ALLEGAN • MICHIGAN
DIVISION STANDARD STEEL SPRING CO.

You Get It in

SUNLIGHT MOTORS

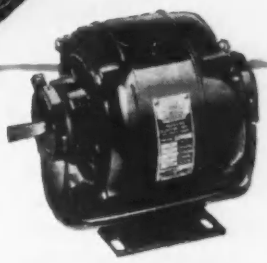
For more than 28 years, Sunlight motors have been built on the policy of providing full measure. There is no skimping on materials, either in quantity or in quality. There is no cutting corners on design.

Proof of the extra value built into Sunlight motors can be found in the features that safeguard performance: the extra-heavy coatings of dielectric insulation that protect motor windings—the extra power that provides up to three times rated starting capacity—the full-gauge copper wire to cut down heat generation—the diamond-bored bearings, set in self-oiling cast bronze journals.

Best proof, though, is the trouble-free performance provided by Sunlight motors in millions of homes, where they drive leading makes of electrical appliances. Manufacturers and dealers know they can depend on Sunlight motors for full measure—in years to come as in years past.

Packard Electric Division, General Motors Corporation, Warren, Ohio

Dependable Appliance Motors for Twenty-Eight Years

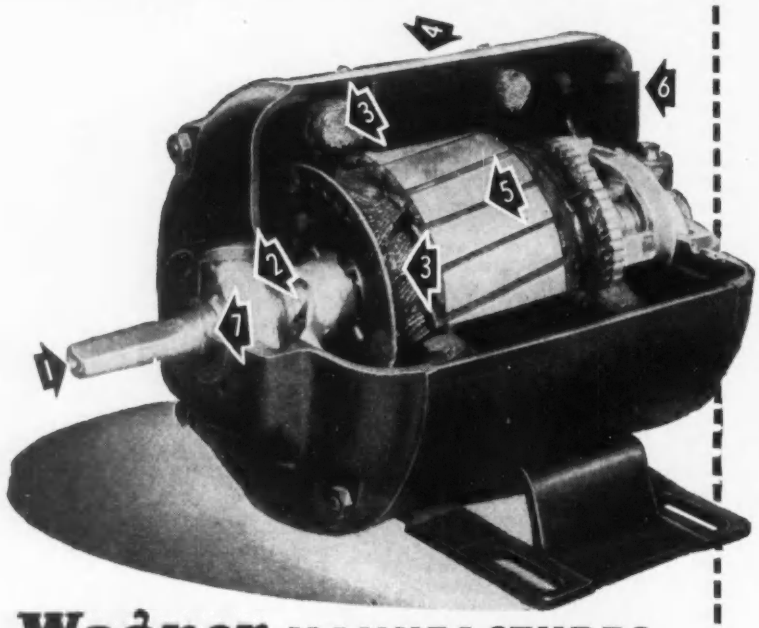


SUNLIGHT MOTORS FOR:

AIR COMPRESSORS
WASHING MACHINES
POWER-DRIVEN BENCH TOOLS
IRONERS
MILK SEPARATORS
MILKING MACHINES
FURNACE BLOWERS
STOKERS
OIL BURNERS
WATER PUMPS
REFRIGERATORS
VENTILATORS
AND MANY
OTHER APPLICATIONS

KEEP BUYING WAR BONDS

Study the Construction Features of this Wagner MOTOR



Designed for Dependable Operation

1. **SHAFT** is designed to carry mechanical overloads without appreciable deflection or vibration.
2. **LUBRICATION** — Long-strand wool yarn is used in all fractional-horsepower motors. Oil-wells are roomy and the yarn supplies plenty of oil, assuring perfect lubrication at all times.
3. **WINDINGS** — The windings of both rotor and stator are of heavily-insulated wire and fit the slots without crowding. Completely insulated and securely wedged into place.
4. **FRAME** — Motor frame is formed from heavy sheet steel. Electrically welded to form a strong, rigid, unbreakable frame that will not get out of alignment.
5. **SLOTS** in rotor are skewed to reduce magnetic noise, and to eliminate variation in starting-torque at different positions of the rotor.
6. **ENDPLATES** are concentrically machined and closely fit accurately machined frames, assuring perfect centering of shaft and uniform airgap.
7. **BEARINGS** are steel-backed for strength and babbitt-lined to minimize wear. They are diamond bored after assembly in endplates and have a mirror-like finish.

Wagner MANUFACTURES A COMPLETE LINE OF MOTORS..

WAGNER SINGLE-PHASE MOTORS—Available in a wide range of sizes and variety of electrical and mechanical types . . . repulsion-start-induction, repulsion-induction, split-phase, capacitor-start induction-run, and shaded-pole.

Mountings: vertical or horizontal, rigid or resilient.

Frames: open, dripproof or explosion-proof.

WAGNER POLYPHASE MOTORS—Available in several types of squirrel cage, wound-rotor, self-excited synchronous (Fynn Weichsel), and special air-conditioning and multispeed types.

WAGNER DIRECT-CURRENT MOTORS—Available in both appliance and industrial types. Compound wound.

MOTORS are but one of several **WAGNER PRODUCTS** serving industry.

Other WAGNER PRODUCTS:
AIR BRAKES
BRAKE LINING
HYDRAULIC BRAKES
INDUSTRIAL BRAKES
INDUSTRIAL BRAKE CONTROLS
TACHOGRAPH (Recording Speedometer)
TRANSFORMERS

These BRANCH OFFICES ARE READY TO SERVE YOU

ATLANTA • BOSTON • CHICAGO • CINCINNATI
CLEVELAND • DALLAS • DENVER • DETROIT
HOUSTON • INDIANAPOLIS • KANSAS CITY
LOS ANGELES • MEMPHIS • MILWAUKEE
MINNEAPOLIS • NEW YORK • OMAHA • PHILADELPHIA • PITTSBURGH • PORTLAND • ST. LOUIS
SALT LAKE CITY • SAN FRANCISCO • SEATTLE
SYRACUSE • TULSA • WASHINGTON, D. C.

Each of these offices is manned by trained field engineers ready to help you solve your motor-drive problems.

Write for Complete Information

M45-2E

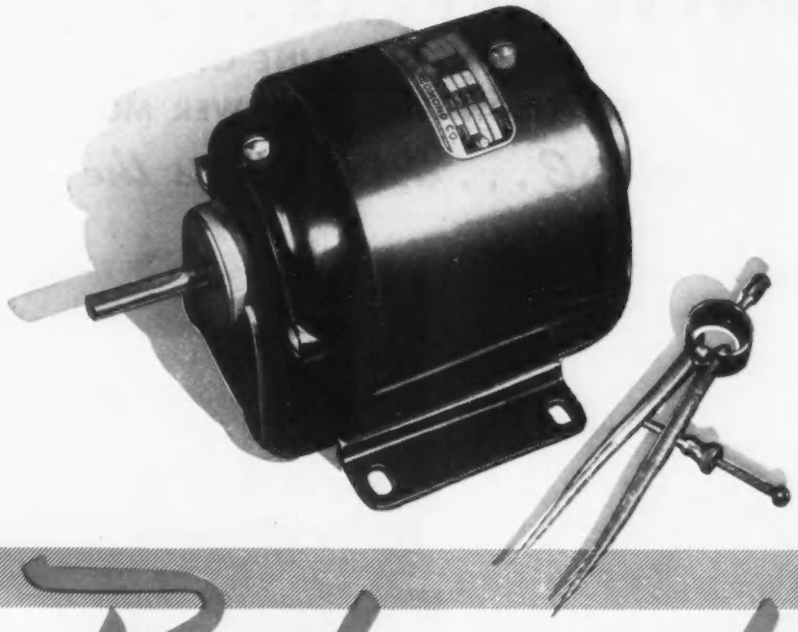
Wagner Electric Corporation

ESTABLISHED 1891

6406 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

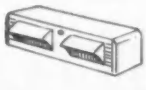
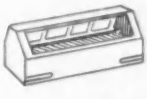
ELECTRICAL AND AUTOMOTIVE PRODUCTS

PRACTICAL



Redmond MICROMOTORS

For Air-Conditioners, Heaters, Ventilators, Display Coolers, Agitators and Ranges

NO GUESSWORK HERE! For continuous duty jobs up to a twenty-fifth horsepower Redmond shaded pole A C Micromotors are engineered to meet your particular requirements.

They're practical little power plants because they're built to last, because they're thoroughly dependable, and readily adaptable, because Micromotors are neat in appearance, compact and quiet running.

You should learn all about their Flush-Weld rotors, Pressure-Locked rubber mountings, Air-Stream cooling and super-capacity lubrication.

Write us today for the complete story of these practical Redmond Micromotors.

A. G. Redmond Company

OWOSSO, MICHIGAN, U. S. A.

REDMOND KNOWS MOTORS

R

REDMOND

Composite view of Redmond facilities with over five acres of floor area.

AC AND DC MICROMOTORS ★ DYNAMOTORS ★ CONTROLLERS ★ BLOWERS

BODINE OFFERS . . .

A FULL LINE OF FRACTIONAL HORSEPOWER MOTORS

AC or DC . . . the frame is the same

DEPENDABLE

PRECISION MADE

QUIET

FINE FINISH

From 1/6 horsepower . . . Bodine's largest motor, down to 1/2000 horsepower . . . Bodine's smallest, there are over 3000 standard specifications to meet every requirement of space limitation and service.

Such wide variety is highly appreciated by designers of small motor driven machines. So, also, are the similar frame designs which permit easy interchangeability of Bodine ac or dc motors. The changeover can be made without extra drilling—without loss of time.

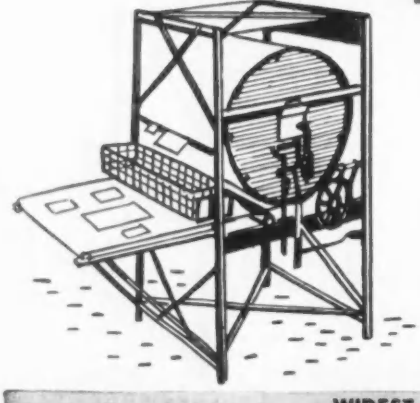
Bodine engineers are expert in motor selection and application. They will gladly help you select the correct motor for the job.

BODINE

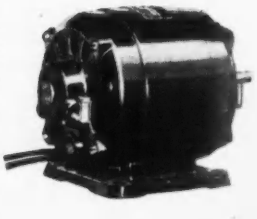
"40 years of progress"

BODINE ELECTRIC COMPANY

2256 W. OHIO ST., CHICAGO 12, ILL.



MODERN PHOTO FINISHING MACHINES EQUIPPED WITH BODINE MOTORS

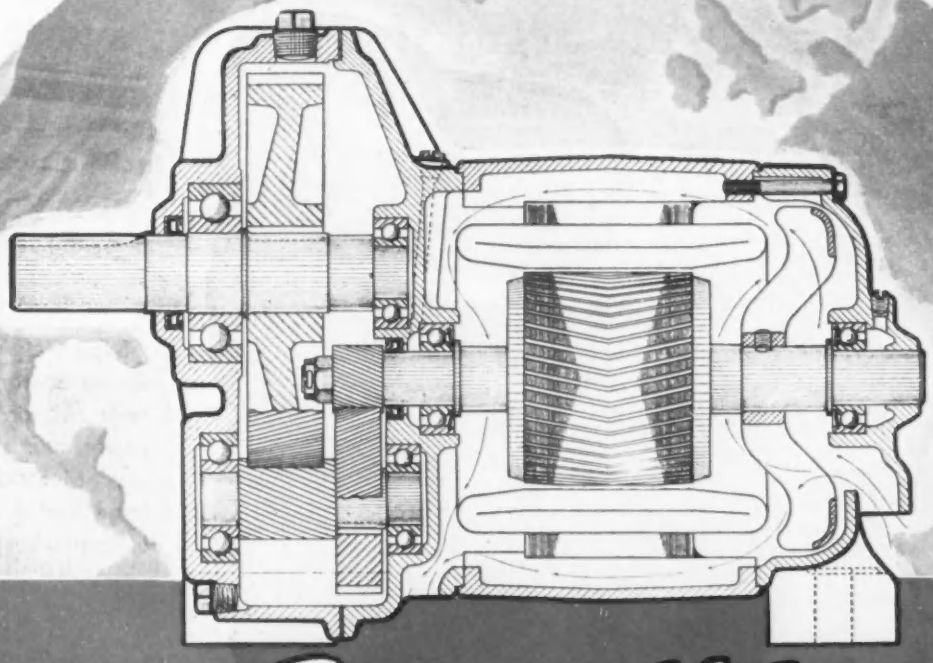


Professional photo finishers rely on automatic developing and printing equipment for speed and accuracy. One of these processes—print drying—consists in applying heat to the prints and turning them on a slowly revolving drum. The speed of the drum is accurately controlled by a small electric motor.

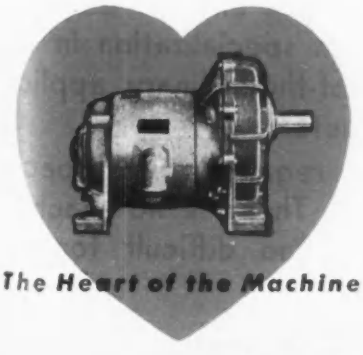
Bodine fractional horsepower motors are used on photo drying machines because of their quick response, reliability, freedom from vibration, and ability to operate over a wide range of speed at low torques.

WIDEST VARIETY OF FRACTIONAL HORSEPOWER MOTORS

A WORLD OF POWER



IN EVERY STERLING SLO-SPEED (Geared) MOTOR



The Heart of the Machine

Sterling Slo-Speed Motors give you a complete power drive in one unit. Compact • flexible • dust-proof • power sealed-in • excellent lubrication • available in all gear ratios.

Sterling Slo-Speed Motors have an efficient, modern gear system, based on sound engineering and years of satisfactory service on machines for all industry.

Write for complete information.

STERLING ELECTRIC MOTORS, INC.

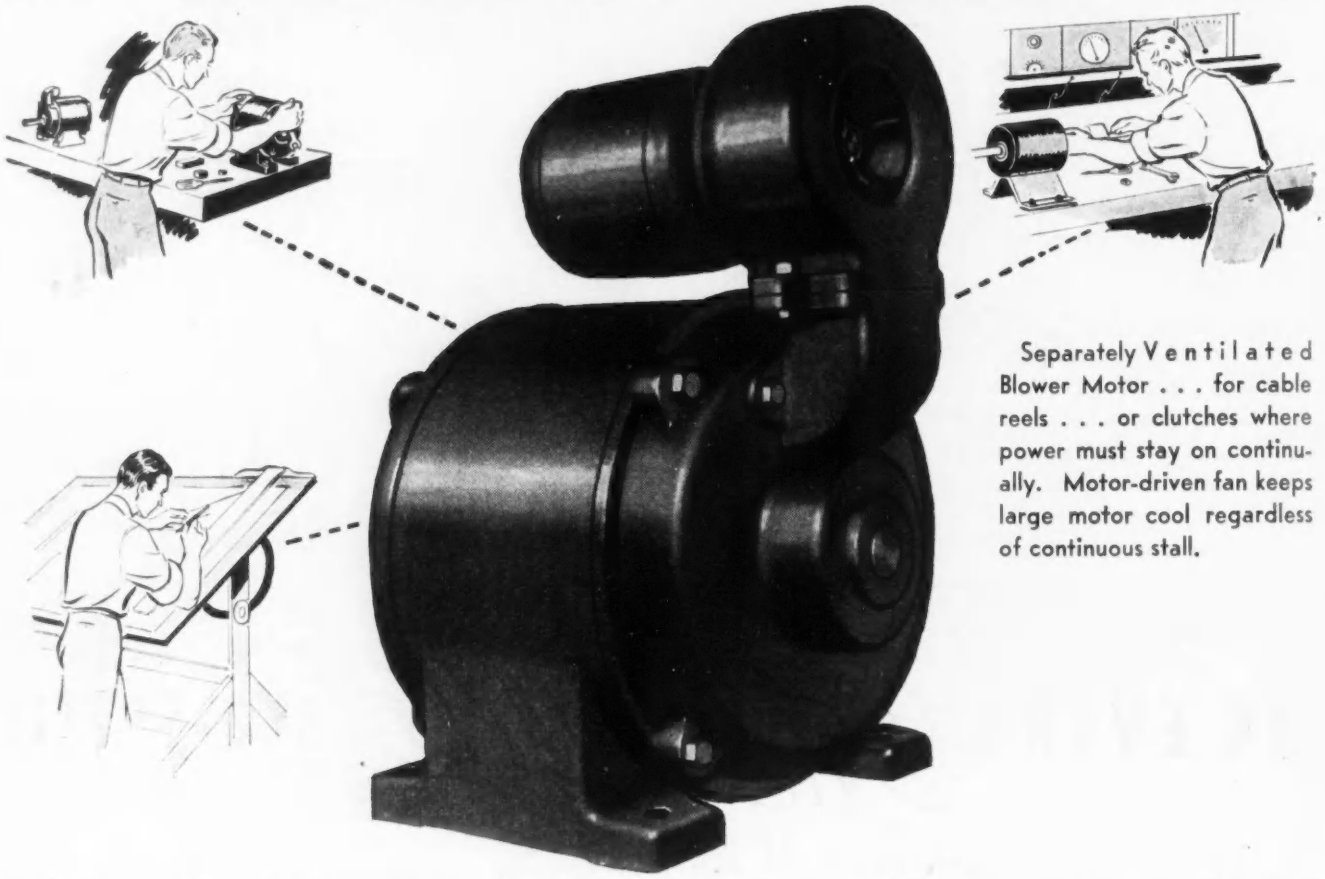
NEW YORK • CHICAGO • LOS ANGELES

REPRESENTATIVES IN PRINCIPAL CITIES

STERLING ELECTRIC MOTORS

for Greater Perform-ability

SPECIALIST - OF SPECIAL TORQUE MOTORS



Separately Ventilated Blower Motor . . . for cable reels . . . or clutches where power must stay on continually. Motor-driven fan keeps large motor cool regardless of continuous stall.

There are literally thousands of Welco "Custom-built" motors in operation. Each one of these special motors is delivering dependable, low-cost service day in and day out . . . and doing it because it was built by the specialist of special motors. The B. A. Wesche Electric Company, for 35 years builder of "Custom-built" motors.

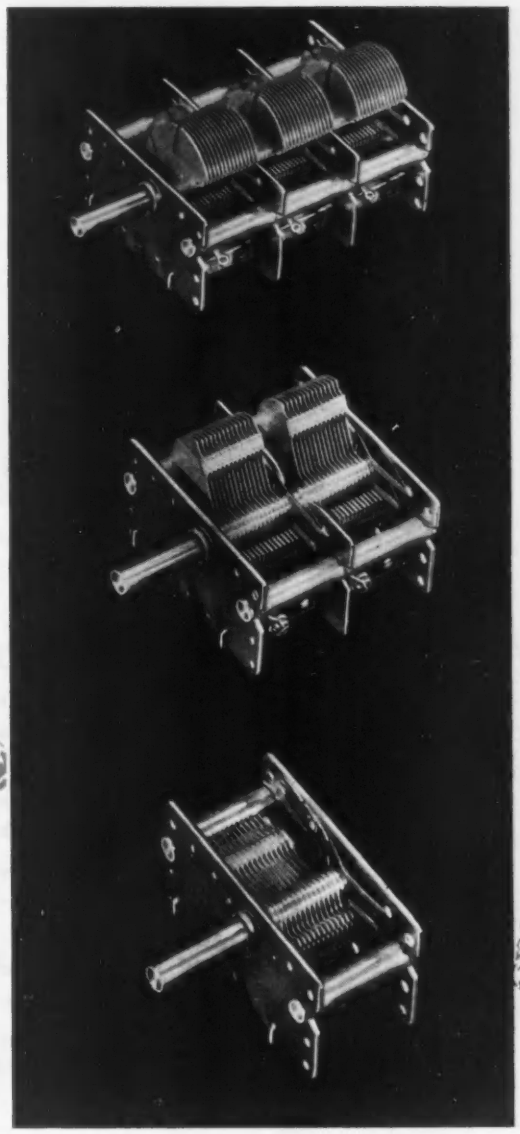
One of the most outstanding features of Welco Torque Motors is their "Uniframe" construction. This provides for an easy change from A.C. to D.C. power or vice versa. However, only Welco Motors have this vitally important interchangeability.

Both the A.C. and D.C. Welco Torque Motors are built to exert torque up to 4000 inch pounds—just another development resulting from specialization in the difficult, the out-of-the-ordinary applications of torque motors.

Write to Welco regarding your special powering problem. There is no machine powering problem too difficult for our engineers to solve.

The B. A. WESCHE ELECTRIC Co.

1620-1 Vine St. Cincinnati 10, Ohio



R/C

23 YEARS

of Variable Capacitor KNOW HOW

ONE after another throughout the long history of Radio, Capacitors have been designed, perfected and mass-produced by R/C.

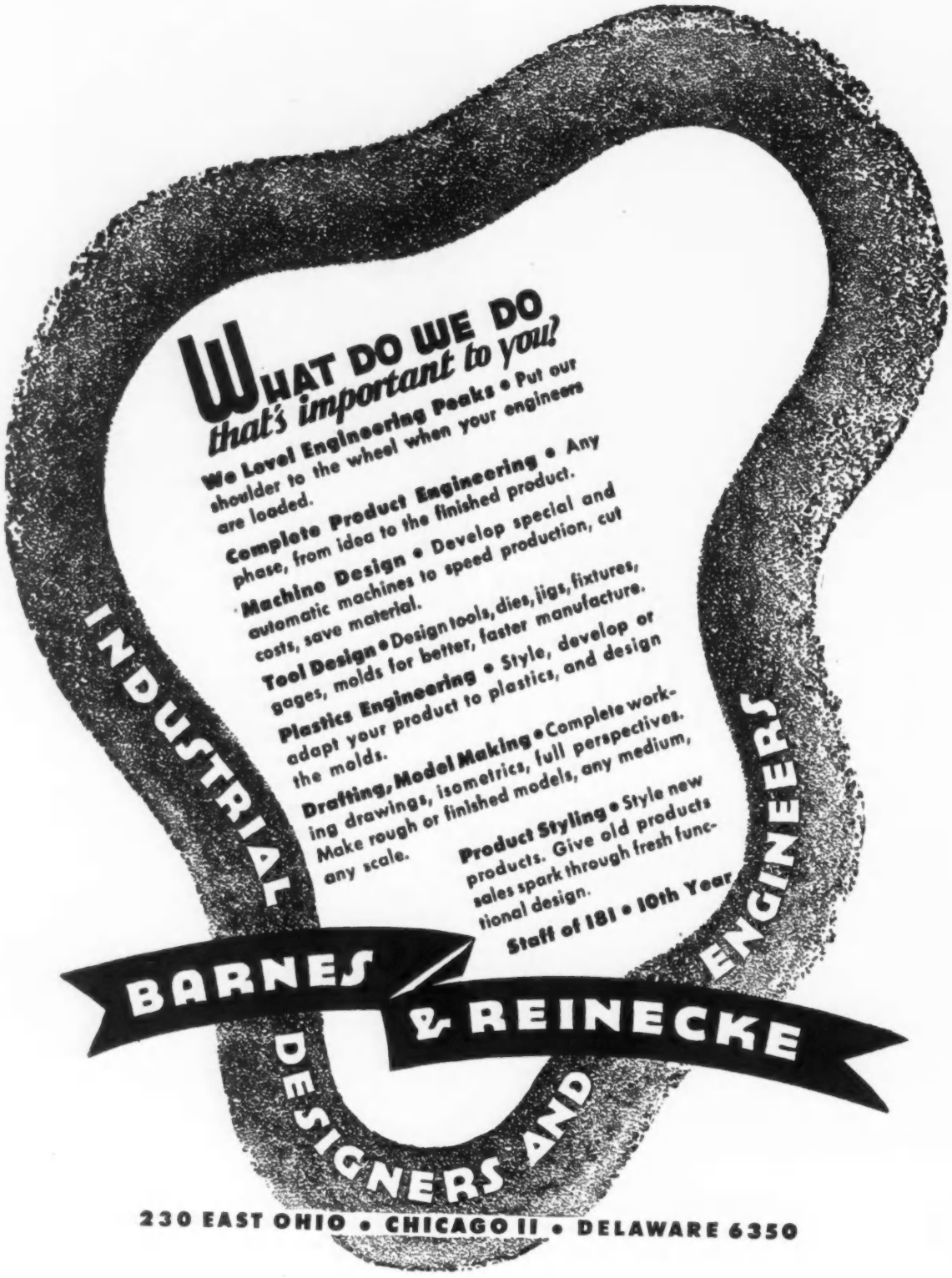
This is the normal result of over 23 years of undivided attention to the proper design, construction and application of this one highly critical, amazingly adaptable component.

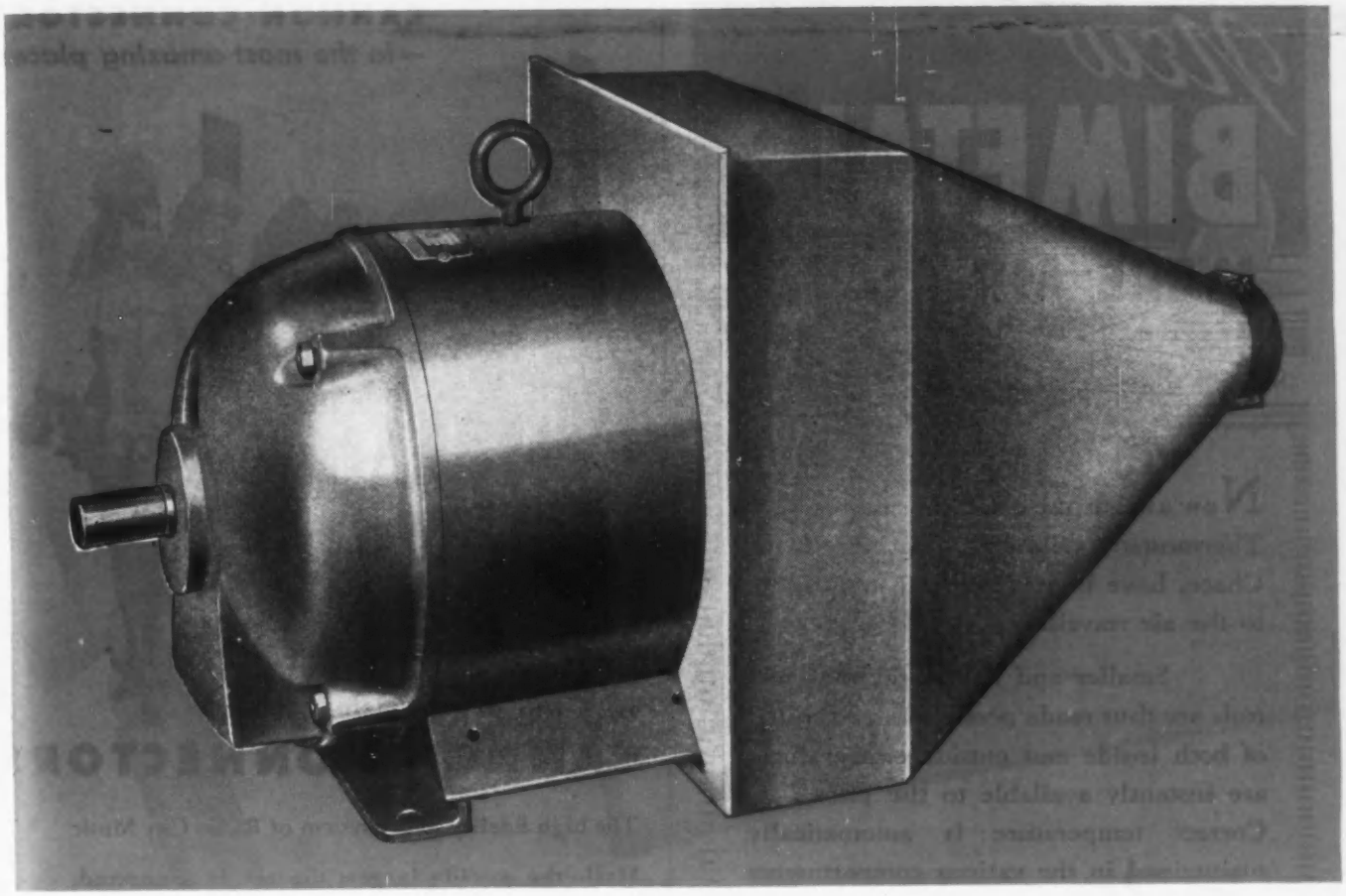
And it is further, the result of the natural development of a group of experts—men who know more about variable capacitor problems and how to solve them than can be found anywhere else in the world.

RADIO CONDENSER CO.

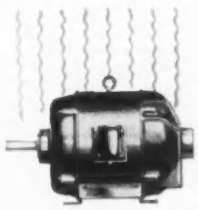
CAMDEN, N. J.

RADIO CONDENSER COMPANY, LTD., TORONTO, CANADA


WHAT DO WE DO
that's important to you?
We Level Engineering Peaks • Put our shoulder to the wheel when your engineers are loaded.
Complete Product Engineering • Any phase, from idea to the finished product.
Machine Design • Develop special and automatic machines to speed production, cut costs, save material.
Tool Design • Design tools, dies, jigs, fixtures, gages, molds for better, faster manufacture.
Plastics Engineering • Style, develop or adapt your product to plastics, and design the molds.
Drafting, Model Making • Complete working drawings, isometrics, full perspectives. Make rough or finished models, any medium, any scale.
Product Styling • Style new products. Give old products sales spark through fresh functional design.
Staff of 181 • 10th Year
INDUSTRIAL DESIGNERS AND ENGINEERS
BARNES & REINECKE
230 EAST OHIO • CHICAGO 11 • DELAWARE 6350



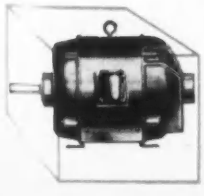
This motor's in the "doghouse" so YOU can stay out!



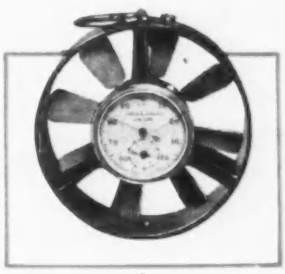
You build a unit that contains a motor. Say the motor overheats, fails. To your customer, it isn't the motor that went haywire, it's *your* unit! You're in the doghouse.

In an effort to prevent motor failures of all kinds, Robbins & Myers research men put R & M motors over every hurdle an engineer can think of (you, as an engineer, know they can think of plenty).

One of many such hurdles is this doghouse test that measures air flow produced by the fans within Uni-Shell Motors of various sizes. How well the fan does its job of controlling temperature rise depends on fan-blade design, fan location, and design and location of motor housing openings through which the air must pass.



To evaluate these factors, to build up a background of fan efficiency, to make certain that you can't go wrong in specifying Uni-Shell Motors for operation in high-temperature or poorly ventilated areas, is the purpose of the doghouse test.



All the air which can be blown through the motor is directed through the cone-shaped box and measured by anemometer in terms of air velocity or air volume.

If you are up against a motor problem, our 20-page, illustrated booklet on R & M Uni-Shell Motors contains plenty of helpful information. A copy is yours for the asking. Send for your copy of Bulletin 1845, today.

SHIPMENT NOW!

Ample stock on most types of integral motors on hand as this goes to press. Wire or phone your inquiry.

ROBBINS & MYERS • INC.

MOTOR DIVISION, SPRINGFIELD, OHIO

HOISTS & CRANES • MACHINE DRIVES • FANS • MOYNO PUMPS • FOUNDED 1878

New BIMETALS MAKE AIR TRAVEL Safer!

New and more quickly responsive Thermostatic Bimetals, developed by Chace, have helped to bring new safety to the air traveller.

Smaller and lighter thermal controls are thus made possible . . . Readings of both inside and outside temperatures are instantly available to the pilot . . . Correct temperature is automatically maintained in the various compartments . . . Constant temperature is supplied to altimeters . . . Circuit breakers—as many as 250 on a single bomber—are all controlled by Thermostatic Bimetal elements.

These same dependable actuating elements for temperature responsive devices are available for the greater efficiency—and salability—of your products. To meet every possible demand, Chace produces 35 different types of Bimetals . . . in strips, sheets . . . in shapes ready for assembly . . . and in completed assemblies with terminals and contacts attached.

Chace engineering knowledge is freely at your disposal. Let us suggest, in confidence, the type of Thermostatic Bimetal best fitted for use in your controls.

W.M. CHACE CO.

Manufacturers of

Thermostatic Bimetals and Special Alloys

1607 BEARD AVE • DETROIT 9, MICH.

CANNON CONNECTORS

—in the most amazing places!

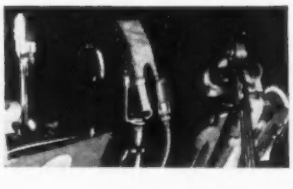
The Rockettes, world-famed precision dancers of Radio City Music Hall

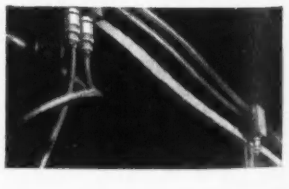
They tap out precision through

CANNON CONNECTORS

The high fidelity sound system of Radio City Music Hall—the world's largest theater, is connected, throughout, with Cannon Connectors. Cannon Plugs were selected for the job because they could be depended upon. They fit with precision, hold tight and are designed especially for the job expected of them.

You can say that about all Cannon Connectors. The same connector precision demanded in aircraft instruments, in radio and television circuits, in technical laboratory circuits, can be had in the circuits you use. All you have to do is specify Cannon Plugs.





Above: Some of the various Cannon Connectors used in the Radio City Music Hall circuits. If you're interested in this type of connector write for P & O Bulletin.

CANNON ELECTRIC

Cannon Electric Development Co., Los Angeles 31, Calif.

Canadian Factory and Engineering Office:
Cannon Electric Company, Limited, Toronto

Representatives in Principal Cities — Consult Your Local Telephone Book

A Standout Among Motor Starters . . .

because of its **COMPENSATED OVERLOAD RELAY**

ONLY OVERLOAD CAN TRIP THIS COMPENSATED RELAY

Monitor's unique Compensated Overload Relay (above) consists of two bi-metal thermally-activated helices. When activated by ambient temperatures, they oppose and nullify each other. Thus, no tripping action is imparted. HOWEVER — one helix is surrounded by a "heater coil" through which flows motor current. When motor current becomes excessive due to overload, the temperature rises in the heater coil . . . is then impressed upon the ONE helix. This produces the motion necessary to open the tripping contact and disconnect the motor from the line.

The Monitor Thermaload V Solenoid Motor Starter . . .

The advantages of Monitor's Thermaload V—with its compensated overload relay—are much too big to overlook. That's because this unique relay—an exclusive Monitor feature—assures thoroughly efficient starter performance regardless of installation peculiarities. For example, in hot locations, the nuisance of unjustified shutdowns is eliminated. In cold locations, this ingenious relay guarantees certain protection against overload. This means that your motors are permanently safeguarded against damage . . . that production schedules can be met without the handicap of unnecessary, periodic interruptions.

In addition to its Compensated Overload Relay, Monitor's Thermaload V starter brings you other important advantages, including (1) Interchangeable coils for different voltages, (2) Double-break silver-to-silver contacts, (3) Tamper-proof reset button, (4) Accessibility of parts for easy maintenance, (5) Built-in quality, (6) Resilient mounting.

Before buying your next motor starter, be sure to get the story on the ingenious Thermaload V from the Monitor Field Engineer in your locality. Or, if you prefer, write us direct for descriptive Catalog 6300.

WE CAN SUPPLY YOU

with the Thermaload V under existing priority regulations from our present stock. Available for motor ratings up to 3 H.P., 110 Volts, A.C. and up to 7.5 H.P., 550 Volts, A.C. Furnished also in combination units . . . combined starter and disconnect switch or combined starter and circuit breaker . . . choice of general purpose, dust-tight or water-tight enclosure. Mounting suitable for front-of-board or back-of-board wiring.

Monitor

The Original

JUST PRESS A BUTTON

The Monitor Controller Company

GAY, LOMBARD & FREDERICK STS. BALTIMORE-2, MARYLAND

CANADIAN AFFILIATE • CANADIAN CONTROLLERS LTD. • TORONTO, ONTARIO, CANADA

IT'S TIME TO INVESTIGATE TIMERS

WHEN PLANNING to build new machinery and equipment . . . or to improve old models . . . be sure to get full information about Paragon Automatic Time Controls. These instruments, when built into numerous types of equipment, save time . . . multiply human output . . . reduce errors . . . increase efficiency . . . and lower costs. They can improve the salability and usefulness of innumerable products and help meet postwar competition.

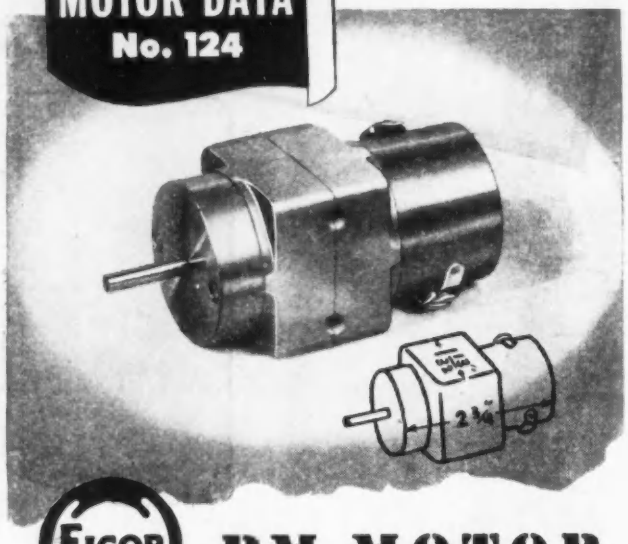
HUNDREDS OF APPLICATIONS—Some of the numerous applications of timers are: Protecting component parts, such as electronic tubes . . . Automatically turning air conditioning units on and off . . . Sequence Timing . . . Laboratory Testing . . . Conveyor Control . . . Light Exposure . . . Heat Treating . . . Pump Operation . . . Machinery operation . . . Plastic Molding . . . Time delay on pump back spin . . . Controlling pre-heating schedules.

ASK PARAGON ENGINEERS . . . about the application of time controls to your problem. Since 1905 these engineers have designed, manufactured and field-studied the operation of industrial timers, time switches, time delay relays and interval timers. They will study your problem and make recommendations without cost or obligation.

PARAGON ELECTRIC COMPANY
708 Old Colony Building
Chicago 5, Illinois

Paragon *Chicago*
BUILDERS OF ELECTRICAL EQUIPMENT SINCE 1905

MOTOR DATA
No. 124

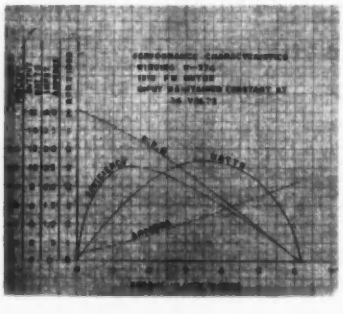


EICOR

PM MOTOR

Torque 3.5 in. oz. at 4500 RPM

Unique in design and construction, this permanent magnet field motor has been selected for many applications having critical space and weight factors. Wound as a shunt motor, its output characteristics are adaptable for a wide variety of power requirements.



PM MOTOR — 1310	
Watts Output Int. (max.)	11
Torque at 7000 RPM (in. oz.)	1
Torque at 4500 RPM (in. oz.)	3.5
Lock Torque (in. oz.)	6
Volts Input (min.)	5
Volts Input (max.)	32
Temperature Rise Int.	50°C
Weight	11 oz.
Shaft Diameter (max.)	.250"
Length less Shaft	2¾"
Overall Diameter	1 13/32"

FEATURES

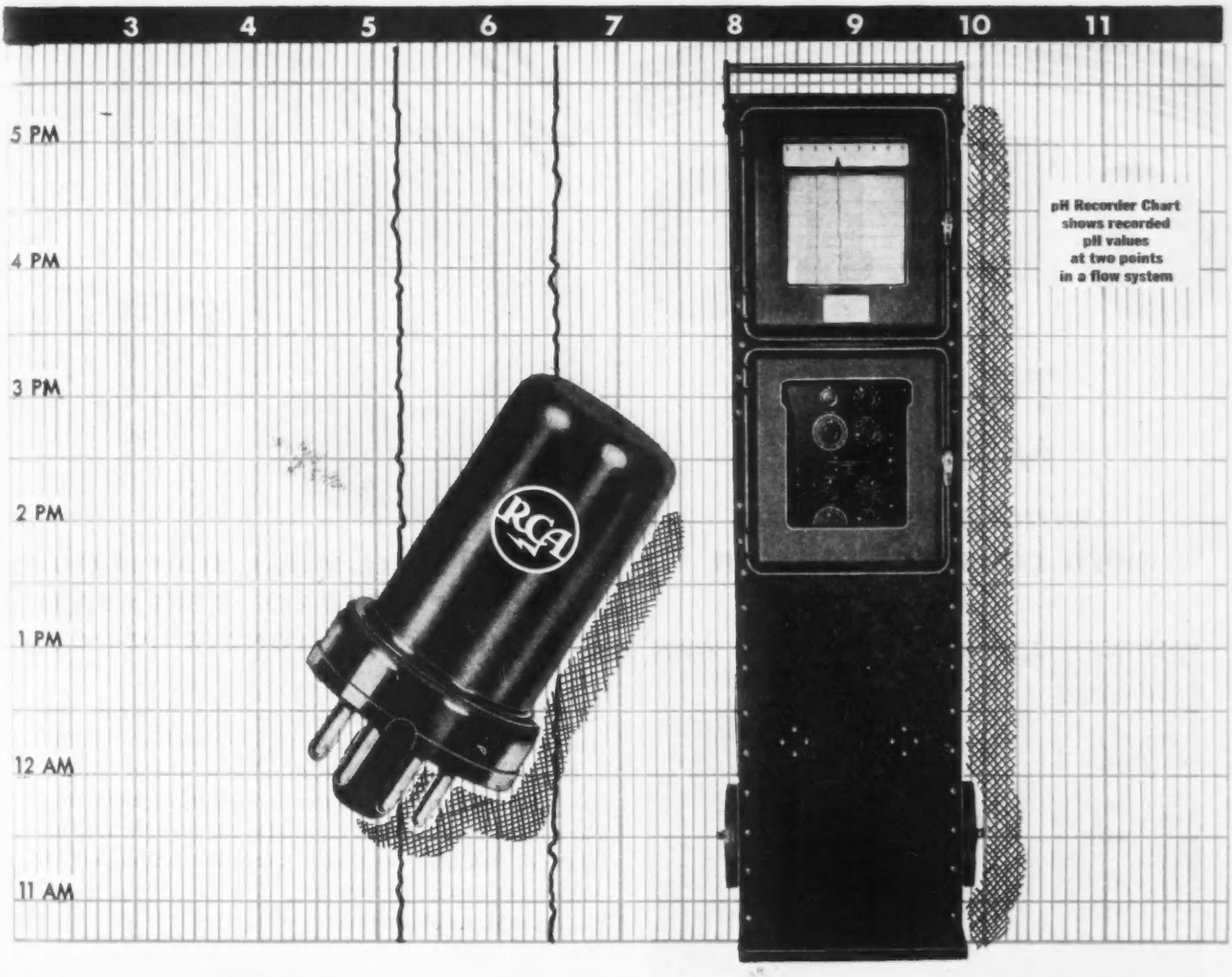
ELECTRICAL

- Alnico field magnets
- No field losses
- Low starting current
- Reversible with change of polarity
- Low RF interference
- Armature windings varnish impregnated and baked

MECHANICAL

- Completely enclosed
- Mounting in any position
- Aluminum end brackets
- Laminated pole pieces
- Stainless steel shaft
- Rotation on ball bearings
- Commutator mica insulated

EICOR INC. 1501 W. Congress St., Chicago, U.S.A.
DYNAMOTORS • D. C. MOTORS • POWER PLANTS • CONVERTERS
Export: Ad Auriema, 89 Broad St., New York, U. S. A. Cable: Auriema, New York



How RCA Tubes Help Test Chemical Solutions

Cambridge Instrument Company's Electronic pH Recorder Warns of Adjustments Needed to Prevent Corrosion and Waste.

CONTROL of acidity or alkalinity in many industrial processes should be immediate, and must be held within specified limits throughout the process in order to prevent corrosion and obtain uniform products.

Ordinarily, samples of the solution are taken at various points in a flow system, analyzed in the laboratory, and the process is adjusted accordingly. But this takes time and offers only a limited accuracy of control . . . with the possibility of human error.

Exit test tubes . . . enter RCA electron tubes!

The electronic pH Recorder developed by the Cambridge Instrument Company, utilizing RCA Tubes, determines and records graphically at a central location the pH value of a solution at several different points. (The pH value of a solution is a number indicating hydrogen ion concentration and, therefore, the degree of acidity or alkalinity of the solution.)

How It Works: In the electronic pH recording system, a glass electrode is immersed in the solution at each point to be measured. The ion concentration, or pH, of the solution produces an electrical potential between the electrode and the solution. Measurement of this minute potential . . . made possible by RCA amplifier tubes . . . indicates the pH of the solution. As many test electrodes can be used as are needed to give accurate, continuous control of the pH of the entire flow system. The electrodes are connected electrically to the central control point, which may be located anywhere.

Applications: The electronic pH recorder makes possible accurate control of the acidity of boiler water feed, corrosion in oil refineries, carbonation in sugar refineries, fermentation in breweries and distilleries, and at numerous stages in the manufacture of paper and textiles.

For Further Information on the electronic pH recorder, write to the Cambridge Instrument Co., Grand Central Terminal, New York City. If you have some *other* problem involving the use of electron tubes, RCA tube application engineers will be glad to help you or put you in touch with a manufacturer who can.

For a copy of the free 32-page booklet, "Electrons in Action at RCA," write to RADIO CORPORATION OF AMERICA, Commercial Engineering Section, Dept. 62-51Y, Harrison, N. J.

Listen to "THE MUSIC AMERICA LOVES BEST," Sundays, 4:30 P. M., E. W. T., NBC Network

THE FOUNTAIN-HEAD OF MODERN TUBE DEVELOPMENT IS RCA

RCA

BUY WAR BONDS

62-6334-51

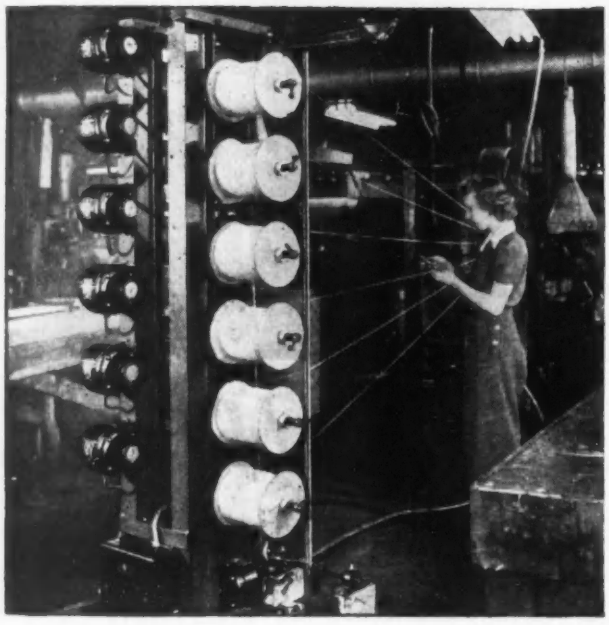
RADIO CORPORATION OF AMERICA

RCA VICTOR DIVISION · CAMDEN, N. J.

OHIO

Measured TORQUE MOTORS wind plastic rod with constant tension

—No breakage—No tangling



Carter Products Corp., Plastic Drawing Machine

In this machine, six strands of plastic spaghetti or other continuous plastic form are produced and reeled while still warm. Formerly the reels were turned mechanically through friction but the strength of the pull could not be kept constant, so the plastic was either stretched or not wound up fast enough. This resulted in uneven dimensions or in snarls at the machine. It was a constant headache.

The installation of six Ohio Measured Torque Motors to drive the reels solved all of the troubles permanently with resulting satisfaction, lower cost and increased production for the manufacturer and also pleased customers.

By using resistance in the 3-phase current to the motors, the pull was exactly measured to the size of product being produced.

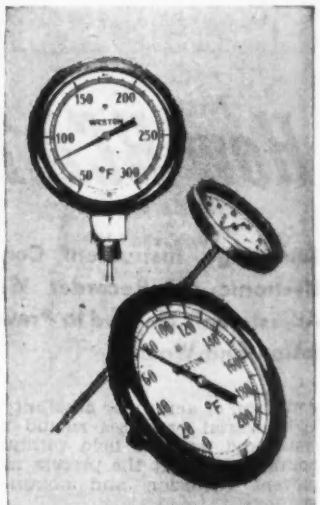
Carter Products Corporation, 6921 Carnegie Avenue, Cleveland 3, Ohio, will be glad to answer questions and our engineers will work with you. What is your problem?

The OHIO ELECTRIC MANUFACTURING Co.
5911 Maurice Avenue, Cleveland 4, Ohio

Eyes RIGHT!

WESTON'S ALL-METAL TEMPERATURE PRINCIPLE ASSURES DEPENDABLE READINGS, OVER LONGER PERIODS!

The *long-term* dependability of the WESTON thermometer stems from its rugged, all-metal construction. It consists of only a simple, durable all-metal temperature element safely encased in a stainless steel stem. No gases or liquids, no capillary, no complicated mechanical linkages, no fragile parts are employed. Because of this extreme simplicity, and the absence of so many common trouble points, WESTONS maintain their high initial accuracy *over far longer* periods. Thus they provide better protection for processes and equipment, and keep replacement and maintenance costs at a far lower level.



WESTON All-Metal Temperature Gauges are available in sizes and types for most industrial needs . . . as well as in laboratory models with full scale accuracy within ½ of 1%.

Literature describing these dependable and rugged thermometers, including types, stem lengths, prices, etc., gladly sent on request. Weston Electrical Instrument Corporation, 684 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *All Metal* TEMPERATURE GAUGES

G.I. IS STILL ON THE MAIN LINE

The first in war industry to be so honored
ARMY E NAVY

G. I.'s main line is still Radio Components—but just now civilian items are sidetracked. We must keep the road clear for all-out war production, which has right of way till that last stop—Victory—is reached. But with that destination reached we're ready to switch right back to mass output of condensers, tuning units, actuators and record changers for home radio sets. Yes, and there's a new "branch" added to our main line—*Speakers,* which we plan to route through in a big way after victory. Meanwhile:

WE STILL HAVE CAPACITY FOR URGENT WAR ASSIGNMENTS!

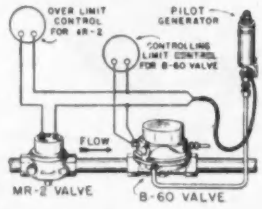
GENERAL INSTRUMENT CORPORATION

829 NEWARK AVENUE • ELIZABETH 3, N. J.

Positive protection against OVER-TEMPERATURE

For the amazing new products of tomorrow . . . as well as the time-tried products of today . . . General Controls' broad line provides a dependable answer to many *automatic control* problems. For example, the *Safety-Control* methods illustrated here may suggest many practical ideas for controlling gas-fired heating equipment.

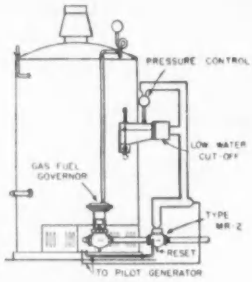
CONTROLLING OVER-TEMPERATURE

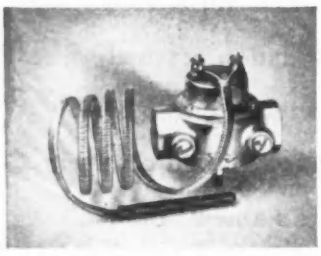


MR-2 with B-60 Gas Valve insures 100% shut-off. Example: On a deep fat fryer, B-60 limit control is set at 380° F.; and MR-2 over-limit control, above 380° but below 410°, the flash point of grease. Should temperature rise over normal 380°, over-limit control releases MR-2 until such time as the operator can attend to the heater.

BOILER SAFETY CONTROL

Low water, over-pressure and pilot failure safety control can be obtained with MR-2 and multicouple pilot generator. This suggests many other safety control applications.





MR-2 THERMOVALVES

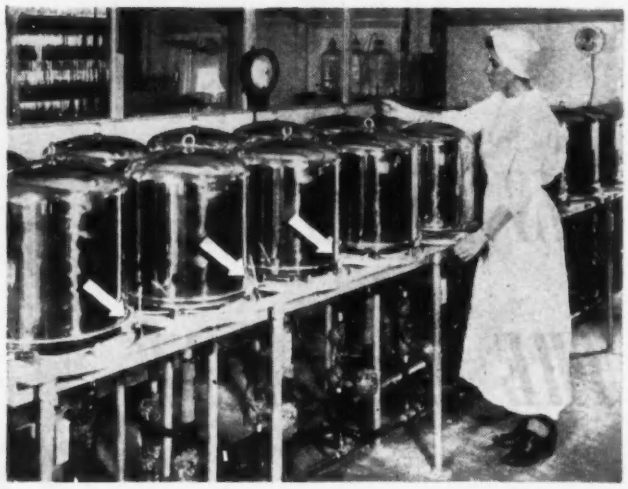
Insure unfailing safety in domestic and industrial gas control systems. Current supplied by multicouple pilot generator or single thermocouple. These electro-magnetic valves handle manufactured, natural or liquefied petroleum gases for gas heaters, furnaces, boilers, ovens and ranges.

IN THE BIG JOB BEFORE YOU, *General Controls' engineers will help you fill your specific needs. For complete specifications on automatic temperature, pressure and flow controls, request Catalog 52B. Nearby is a factory branch office or distributor equipped to meet your requirements.*

GENERAL CONTROLS
801 ALLEN AVENUE GLENDALE 1, CALIF.
BRANCHES: Atlanta, Boston, Philadelphia, San Francisco, Denver, Chicago, Kansas City, New York, Cleveland, Detroit, Dallas
Distributors in Principal Cities

LIFE-GIVING BLOOD!

. . thanks to temperature control



Plasma reduction units depend on THERMOSWITCHES for accurate regulation.

THERMOSWITCHES shown by arrows in Laboratory Reduction Room.

Write for catalogue and complete information . . . to
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If your production is held up waiting for blueprints from outside firms, then a Wickes Simplex Portable Blueprinter will solve your problem in a hurry. This speedy machine processes up to 48" per minute with a maximum width of 42". For blueprints, Van Dykes or other special developing processes. Mercury vapor tube heats up in 55 seconds. Requires no experience—your office girl can operate. Low initial cost. Uses a minimum of electricity. Prints sheets or continuous rolls. Requires very little space. Write for complete information to:

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510 NORTH WATER STREET

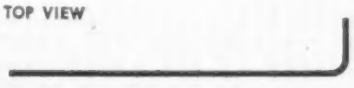
LET SIMMONDS ANALYZE YOUR CONTROL PROBLEM

Simply submit the basic requirements, as follows:

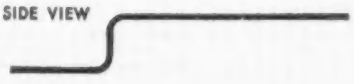
- **What does the control operate?**
- **LOAD: Compression (lbs.) Tension (lbs.)**
- **VIBRATION CHARACTERISTICS**
- **TEMPERATURE CONDITIONS**
- **PRESENT SYSTEM**
- **FLEXIBLE OR RIGID HOUSING?**

Make sketches of top and side views of installation. Use regular graph paper and indicate unit of measure.

TOP VIEW



SIDE VIEW



SIMMONDS EQUIPMENT FLIES WITH EVERY TYPE OF ALLIED AIRCRAFT

Automatic Engine Controls — Push-Pull Controls
Spark Plugs — Hydraulic Accumulators
Hydraulic Fuses — Chronometric Radiosondes
Fasteners and Clips of Specialized Design

TOUGH but typical of the remote control problems successfully solved by the Simmonds precision-built Push-Pull Controls is the one described above. Designed to meet the exacting conditions of aircraft operations, more than half a million Simmonds Controls are today flying on every Allied battlefront. Increasingly, Simmonds Controls are also being specified for installation on tanks, ordnance, automotive and industrial units to replace cumbersome rod and bellcrank or pulley and cable systems, and even pneumatic lines.

Basically, the Simmonds precision-built control consists of a series of "metal beads" strung on a cable and enclosed in either a rigid or a flexible tubing. The "beads" give the push and the cable the pull — hence the push-pull of two-way control. Straightline travel can be transformed into rotary motion by means of the Radian Unit; a variety of other fittings and accessories are available.

Under difficult conditions involving bends and detours around fixed installations, or involving vibration or relative motion between two units, and wherever the ultimate in precision remote mechanical control is required, Simmonds Controls are proving their outstanding merit.

Let Simmonds engineers help solve your remote control problems. For a free and constructive analysis, send data concerning your requirements, as suggested in the panel at left, to the nearest Simmonds office.

Simmonds
AEROCESSORIES, INC.
30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

Simmonds PRODUCTS INC.

BRANCH OFFICES: DAYTON · WASHINGTON · GLENDALE, CAL. · MONTREAL
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RADIO, SOUND AND COMMUNICATIONS EQUIPMENT?

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Hearing Aids
Electrical Musical Instruments
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Polarized Relays
Generators
Meters
Magnetron Fields

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Motors
Speedometers
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Oscillographs
Flux Meters
Watt-hour Meters
Flow Meters
Light Meters
Cardiograph Recorders
Vibration Pick-ups

MISCELLANEOUS PRODUCTS?

Magnetic Separators
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Magnetic Damping Devices
Arc Blow-out Magnets
Temperature and Pressure Control Equipment
Circuit Breakers
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IF YOU make any of the above products, it will pay you to find out how *better permanent magnets* can improve efficiency and reduce costs. Put your design, development or production problems up to The Arnold Engineering Company. Arnold engineers have been of great assistance to many manufacturers and are at your service to advise exactly what Alnico permanent magnet will solve your particular problem.

NEW! Get your copy of this valuable, up-to-the-minute manual on the design, production and application of modern Alnico permanent magnets. Write us, on your company letterhead, today.

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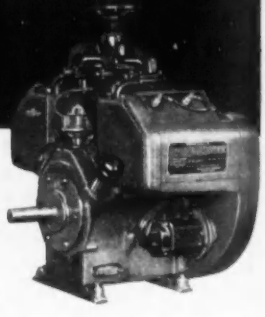
Specialists in the manufacture of ALNICO PERMANENT MAGNETS

AGASTAT
ELECTRO-PNEUMATIC RELAY

FOR DIVERSITY IN TIME DELAY APPLICATIONS

ELIZABETH A'G'A NEW JERSEY
AMERICAN GAS ACCUMULATOR COMPANY

All WISCONSIN HEAVY-DUTY Air-Cooled ENGINES



are equipped with
EXTENDED SHAFT
for Power Drive

You have no outboard bearing problem in rigging up a power take-off when the power unit is a Wisconsin Air-Cooled Engine.

All Wisconsin Air-Cooled Engines are equipped with an extended shaft, which is an integral part of the crankshaft proper. Drive pulley, sprocket, gear drive or direct-connected coupling can be attached directly to this extended crankshaft . . . because all Wisconsin Air-Cooled Engines are equipped with *tapered* Roller Bearings at both ends of the crankshaft to take up end-thrust and carry the power load.

This is a feature frequently overlooked by the purchaser of an engine . . . but it is NOT overlooked in the manufacture of Wisconsin Engines . . . built for efficiency and dependable service in *all* ways.

Most H.P. per pound
WISCONSIN MOTOR
Corporation
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

CREATIVE ELECTRICAL ENGINEERING

There are few industries in which post-war planning does not involve *Creative Electrical Engineering* ability of the highest order. The exacting competitive situation developing demands topnotch skill.

On its record, LELAND Electric has earned your consideration. Our experience and ingenuity in solving tough electrical problems may prove immensely valuable to you.

We invite you to consult with us.

THE Leland
ELECTRIC COMPANY

DAYTON 1, OHIO

In Canada: Leland Electric Canada Ltd., Guelph, Ontario

Alternator

Self-excited, can be used with electric motor or gasoline drive, up to 2½ KW output, general purpose electric power supply.

K-C MOTORS

are equal to the task . .

K-C Capacitor Start Induction Motors, designed for high starting, accelerating and maximum torques: ¼ to ¾ H.P., 1725 R.P.M. and up to 1½ H.P. 3600 R.P.M.

Whether the application calls for continuous or intermittent service, high or low starting torque or other specific requirement, there is a K - C motor which can be depended on to meet all the conditions involved. Performance under any condition, as proved by experience, is consistently trouble-free, highly efficient and low in operating cost, advantages which are of outstanding importance and value for future motor-driven equipment.

KINGSTON-CONLEY ELECTRIC COMPANY

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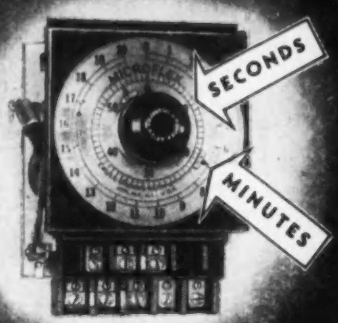
MICROFLEX

With Micrometer Dial for Precision Timing



TIMING RELAYS

★ Accuracy within + 0.1 of 1% of time scale.
★ Time setting adjustable over 1 to 600 ratio
★ 6 operating and contact arrangements

For machine tools, molding presses, heat treating, and other applications where an accurate and dependable timing relay is required.

WRITE TODAY! Bulletin No. 291
For complete data on Eagle Timers and count relays.

EAGLE SIGNAL CORPORATION

MOLINE, ILLINOIS

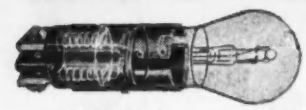
TIMING RELAYS REPEAT TIMERS COUNT RELAYS

SOCKETS

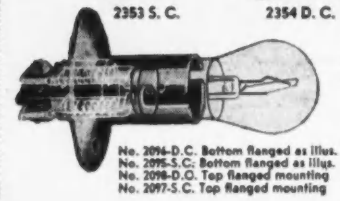
ENGINEERED BY *Cole-Hersee*

FOR NEW TYPE OF NEON AND ARGON GLOW LAMPS

SINGLE CONTACT SOCKETS



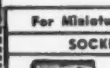
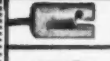
2353 S. C. 2354 D. C.



No. 2096-D.C. Bottom flanged as illus.
No. 2095-S.C. Bottom flanged as illus.
No. 2098-D.O. Top flanged mounting
No. 2097-S.C. Top flanged mounting

DOUBLE CONTACT SOCKETS

For Miniature Base Single Contact Only

SOCKET	SOCKET HOLDER
 No. 2501 Diameter .425 in.	¾ in. Long Brass, Nickel Plated
 No. 2502 Diameter .425 in. 17/32" Long	Sleeve No. 2902 Socket and Sleeve Both Brass, Nickel Plated
No. 2503 Diameter .425 in. 21/32" Long	Holder No. 2901

FOR THE FOLLOWING NUMBERS

NE-42
NE-36
NE-32
NE-26
NE-48
NE-15
NE-21
NE-17
AR-2
AR-4

Heavy Screw Terminals permit easy attachment of resistors and wire leads.

If you have a problem in switch or socket application bring it to Cole-Hersee for prompt action.

Cole-Hersee Company

54 OLD COLONY AVE. BOSTON 27, MASS.

long life expectancy here...

they're Callite silver contacts...

In high-speed switching you can get sharp, positive action, free from chatter and bounce with Sigma "Sensitive" Relays. The Sigma Type 4-A, containing Callite Silver Contacts, with total operating delay held in the vicinity of one millisecond, permits up to 120 contacts per second, even under severe vibration and at extremes of temperature and pressure.

For applications in extremely high speed keying operations, where the keying frequency runs as high as 60 to 100 cycles per second, the life expectancy of the Callite Silver Contacts extends to 50 or 100 million operations.

If you are looking for contacts engineered to "make and break" with precision, consider Callite's wide range of types and materials. Let us cooperate on specific applications. We may be able to save you time and money. Callite Tungsten Corporation, 551 Thirty-ninth St., Union City, N. J. Branch Offices: Chicago, Cleveland.

Callite CONTACTS

Standard and special shapes in tungsten, molybdenum, silver, platinum, palladium, and alloys of these metals. Send for Contact Catalog No. 152.

CALLITE TUNGSTEN CORPORATION C.T

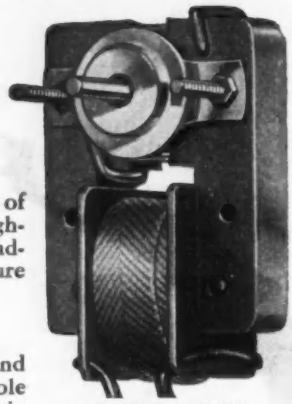
1,001 USES

Condensed Power for Years of Service

VERSATILITY and dependability were paramount when *Alliance* designed these efficient motors—*Multum in Parvo!* . . . They are ideal for operating fans, movie projectors, light home appliances, toys, switches, motion displays, control systems and many other applications . . . providing economical condensed power for years of service.

Alliance Precision

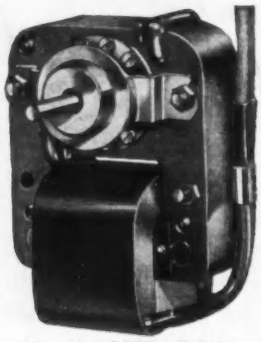
Our long established standards of precision manufacturing from highest grade materials are strictly adhered to in these models to insure long life without breakdowns.



Model "MS"—Full Size Motor Measures 1¾" x 2 x 3⅛"

EFFICIENT

Both the new Model "K" Motor and the Model "MS" are the shaded pole induction type—the last word in efficient small motor design. They can be produced in all standard voltages and frequencies with actual measured power outputs ranging upwards to 1/100 H. P. . . Alliance motors also can be furnished, in quantity, with variations to adapt them to specific applications.



New Model "K"—Full Size Motor Measures 2⅛" x 2⅝" x 3 1/16"

DEPENDABLE

Both these models uphold the *Alliance* reputation for all 'round dependability. In the busy post-war period, there will be many "spots" where these Miniature Power Plants will fit requirements . . Write now for further information.

Remember Alliance!
—YOUR ALLY IN WAR AS IN PEACE

ALLIANCE MANUFACTURING CO.

ALLIANCE . OHIO

TO PUT "SPOTS OF HEAT" INTO ANY MACHINE

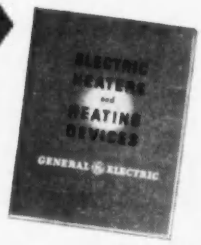
G-E CARTRIDGE HEATERS

(One of the popular G-E midget heaters)*

Use these convenient electric heaters to build localized spot-heating into processing machinery, such as embossing presses, die blocks, sealing machines, glue pots, etc. Easily installed—simply drill a hole in the part to be heated, insert the cartridge heater, and connect into the nearest outlet. Unusually durable, they give long efficient service. Temperatures up to 1200 F. Sizes from 1½ to 8½ inches long. **PRICES FROM $2.20**

SEND FOR GED-650

Here, in one small book, are the answers to the hundreds of small heating problems that arise daily in industrial plants to puzzle electrical engineers, superintendents, foremen, owners, and maintenance men. *General Electric Co., Schenectady 5, N. Y.*



*OTHER G-E HEATERS: CARTRIDGE HEATERS • HEATING CABLE • CONVECTION HEATERS • CALROD IMMERSION HEATERS • STRIP HEATERS • CALROD HEATERS • FIN CALROD HEATERS

GENERAL ELECTRIC

670-88-8709

GIBSON offers A COMPLETE ELECTRICAL CONTACT *Engineering service*

Each contact application involves so wide a variety of conditions that we realize it is essentially an engineering problem. Gibson Service includes all phases of contact engineering:

1. Design
2. Selection of materials
3. Selection of form
4. The manufacture of individual contacts and assemblies.

We are specialists in the field of electrical contacts and will gladly assist you in finding the most efficient solution to your contact problems. Write today.

*First of a series

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Manufactured by
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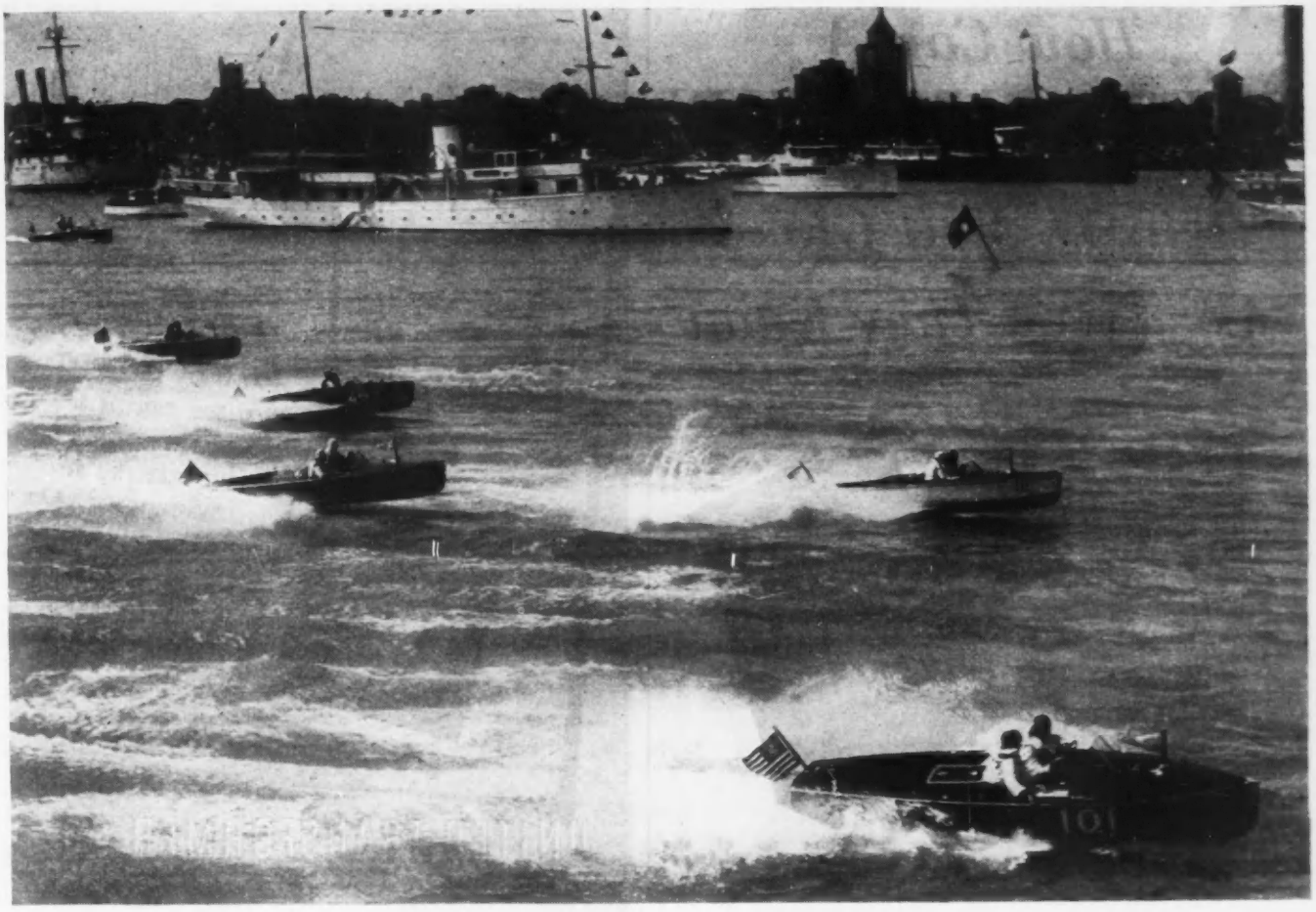


AWAY AHEAD!

Tobe Leads the Noise Elimination Field

WHAT are the real problems of radio noise interference? Can all man-made spark interference be eliminated? What is a sound source of information for the many problems concerning this entire subject?

The place to get these answers is at Tobe. For Tobe is the acknowledged leader in this field. For 17 years this organization has devoted its resources to the problems of noise elimination.

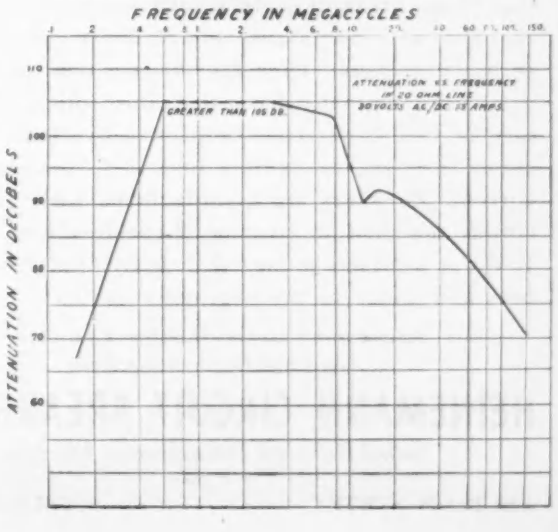
Tobe Filterizing is a copyrighted term describing the Tobe system of blotting-out unwanted "man-made" noise. Why not make use of our valuable experience? Write us about your problems.

TOBE DEUTSCHMANN CORP., CANTON, MASS.

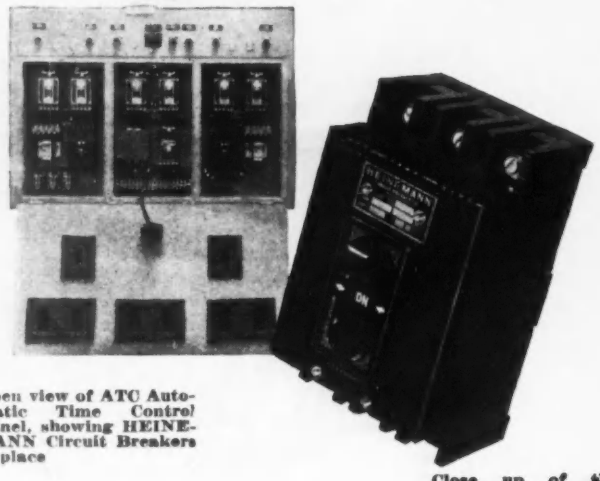
SUPPRESS MAN-MADE RADIO STATIC
TOBE
FILTERIZED

CONTAINER DIMENSIONS

Length	3 1/16"
Width	2 1/8"
Height	2 7/8"
Overall length	5 7/32"


FREQUENCY IN MEGACYCLES
ATTENUATION IN DECIBELS
GREATER THAN 100 DB
ATTENUATION VS. FREQUENCY IN 20 OHM LINE 30 VOLTS AC/DC 15 AMPS

How Can A HEINEMANN *Magnetic Circuit Breaker Help To Melt Glass? Ask* atc *—They Know*



Open view of ATC Automatic Time Control Panel, showing HEINEMANN Circuit Breakers in place

Close up of the HEINEMANN Magnetic Circuit Breaker

When Automatic Temperature Control Co., Inc. wanted dependable equipment to be used as component parts in conjunction with the A T C complete line of automatic time controls, they turned to HEINEMANN for the protective device. And when the Hartford-Empire Co. developed its revolutionary new method of glass melting, the HEINEMANN Magnetic Circuit Breakers on the time control panels supplied by A T C bore the responsibility of protecting many thousands of dollars worth of vital equipment. It may be that HEINEMANN Magnetic Circuit Breakers can perform an equally important service for you.

"*Fully Magnetic*" describes the most important feature of the HEINEMANN Circuit Breaker. This means that these breakers have a fully electro-magnetic trip unit that acts instantaneously on short circuits or dangerous overloads. They also have a true inverse time delay in a hermetically sealed unit which allows passage of inrush current. Continued overload, however, opens the breaker in time inverse to the ratio of the current. Breakers are manufactured with time delays closely matched to customer's specification. Magnetic Blowout Contacts mounted in individual arcing chambers add speed to the arc interruption.

Send for Catalog Showing Complete Line and Engineering Data

HEINEMANN CIRCUIT BREAKER CO.

Subsidiary of Heinemann Electric

Est. 1888

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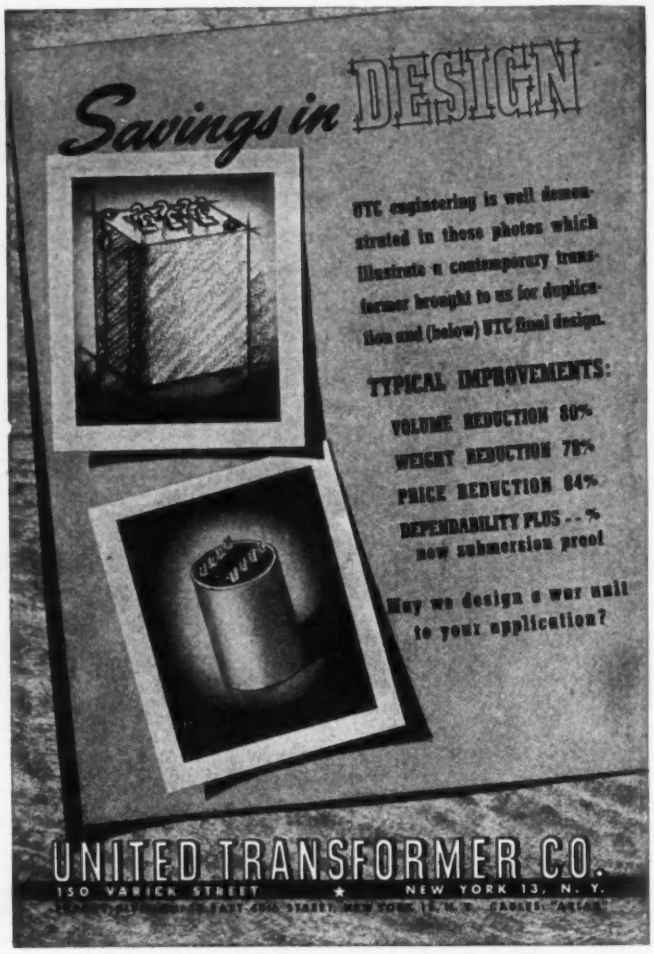
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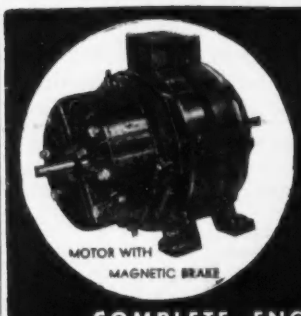

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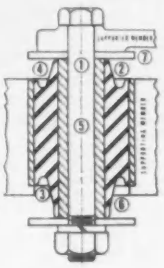
For Better Control of Vibration

LORD
SHEAR TYPE
Bonded Rubber
MOUNTINGS

TUBE FORM



1. **End Extensions**—Provide clearance between the metal members for free movement in shear.
2. **End Shape**—Throws flexing action away from the metal parts into the rubber body, preventing stress concentration at the edge of the bond.
3. **Rubber-to-Metal Bond**—Lord Methods produce a high ratio of bond strength to working stress, resulting in a large factor of safety.
4. **Rubber Compounds**—Developed particularly for shear type mountings and may be changed in properties to suit a wide range of conditions.
5. **Center Sleeve**—Dimensions may be changed to meet any unique installation conditions.
6. **Sound**—Use of Lord mountings eliminates noise normally transmitted through solid metallic paths.
7. **Safety**—Metal washers, installed as shown, limit movement under ordinary overload or shock. If excessive overloads cause the rubber to fail, the suspended member will not be released without breaking one of the metal parts.

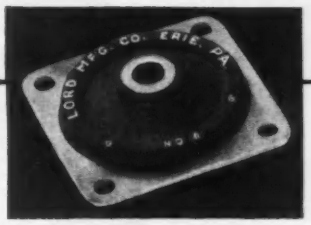
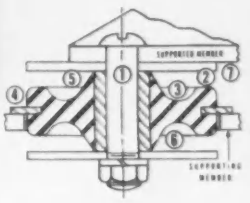


PLATE FORM



1. **End Extensions**—Provide clearance between center metal member and rubber Snubbing Shoulders for free movement in shear.
2. **Snubbing Shoulders**—Arrest shock movement and supply a cushioned stop on contact with metal washers.
3. **End Shape**—Throws flexing action away from metal parts into the rubber body, preventing stress concentration at the bond.
4. **Rubber-to-Metal Bond**—Lord Methods produce a high ratio of bond strength to working stress, resulting in an ample factor of safety.
5. **Rubber Compounds**—Developed particularly for shear type mountings may be changed in thickness of body and in properties to suit a wide range of conditions.
6. **Sound**—Use of Lord mountings eliminates noise normally transmitted through solid metallic paths.
7. **Safety**—Metal washers, installed as shown, make up an inter-locking system of metal parts, which limit and cushion excessive movement under conditions of overload or shock.

FOR more than twenty years Lord's business has been the isolation and control of vibration. Lord has lifted the methods of attack on the destructive forces of vibration to a highly developed science. When Lord engineers make a study of your plant or your product, there's no guesswork about their recommendations.

Lord's *Bonded Rubber* Shear Type Mountings embody many exclusive patented features available only in Lord Mountings. Typical methods of installation and design features are shown above. Lord's special bonding process insures a bond between rubber and metal that is as strong or stronger than the rubber itself. The contour of the rubber element is designed to throw flexing action away from the metal parts into the rubber body, preventing concentration of stress at the edge of the bond. Countless formulae developed through years of experience and scientific control of compounding methods enable Lord to produce a rubber body with the exact degree of stiffness and other qualities needed for the job the mounting is required to perform. Lord's bonding process leaves the rubber body in a natural state of rest, with no "built-in" stresses of tension, compression or torque, to detract from its full potential in combatting the forces of vibration over a long service life.

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In the Air *or on the Ground...*

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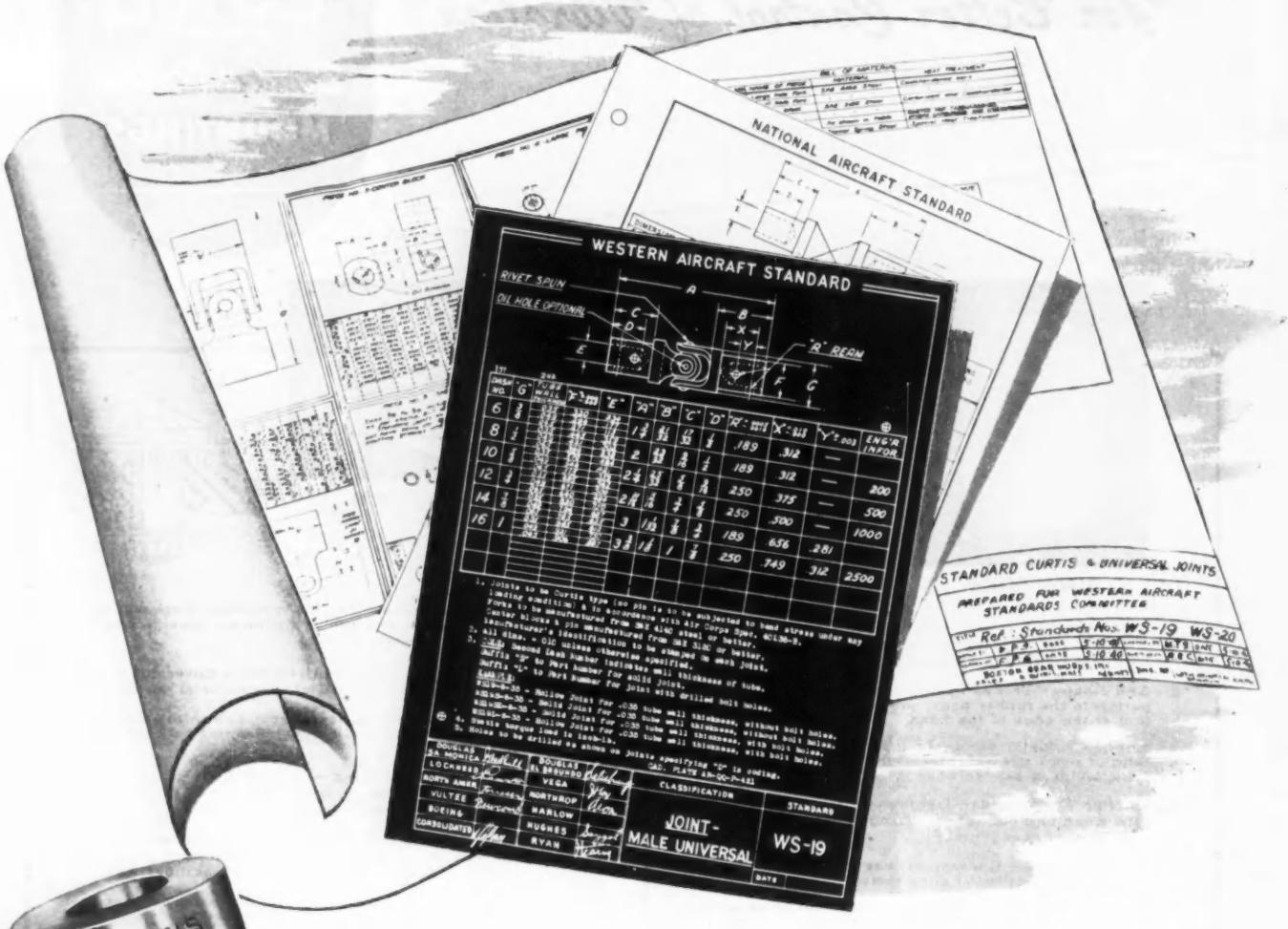

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The I-S SPRINGBOARD

VOL. 1 NO. 2

Published by INSTRUMENT SPECIALTIES CO., INC.

234 BERGEN BOULEVARD — LITTLE FALLS, NEW JERSEY

FILEWORTHY FACTS ABOUT MICRO-PROCESSED BERYLLIUM COPPER

NEW I-S PROCESS FOR SPIRAL BRUSH SPRINGS

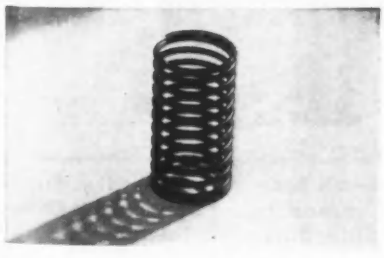
Instrument Specialties has recently perfected a new method for making spiral springs used for motor brushes. These springs are produced with uniformly concentric coil; the angle between ends being held to close tolerance. More information will be detailed in a later issue of "The Springboard."

LITERATURE

Write for Your Copy

An article by H. G. Williams, Chief Metallurgist of I-S, was published recently in "Metal Progress" entitled "Availability of Beryllium in Copper." This article points out the fact that beryllium-copper, having the required analysis, may fail to develop expected properties. Beryllium present but not "available" for hardening is often responsible for this trouble, as well as for certain difficulties encountered in fabrication.

MICRO-PROCESSING SOLVES ENDURANCE PROBLEM



A Sensitive Control device required a spring produced to relatively close tolerances, and calibrated after assembly. Elimination of drift was essential, to maintain initial calibration. Also, the control device had to be designed to withstand rapidly repeated load cycles in a corrosive atmosphere.

Micro-Processed Be Cu, as shown in chart at the right, offered a design solution meeting all performance requirements. The I-S Spring developed for this application (see illustration) required considerably less space because of higher safe working stresses.

ONLY BERYLLIUM COPPER^{mp} MEETS REQUIREMENTS OF BINOCULAR FILTER PART

Beck-Lee Design Made Possible by Using Beryllium Copper to Fullest Potentialities

The Glasser Filtrol binocular attachment shown here is a removable variable density filter which makes it possible to spot airplanes when looking directly into the sun. As the plane leaves the sun, the filter can be adjusted instantly to give less filtering, and as the plane leaves the sun area entirely and no polaroid is necessary, the unit is quickly flipped off of the binocular by the user.

Numerous critical demands had to be met before the unit would assure desired results. The drawn cup part also illustrated, which snaps over the binocular eye-piece, had to be made to close tolerances in all physical dimensions. At the same time the spring action of 10 tongues formed in the side of the cup had to be controlled within close limits.

A high strength material was demanded in order to withstand the repeated attachment and detachment of the unit, and a high degree of corrosion resistance was essential.

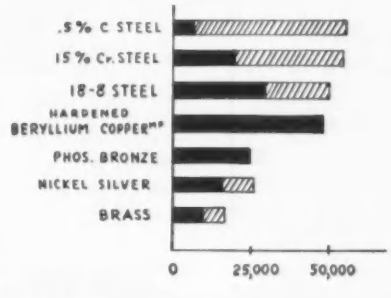
Engineers of the Beck-Lee Corporation, Chicago, Ill., knowing the possibilities inherent in Beryllium Copper^{mp}, with the assistance of the I-S engineering department developed the design to be micro-processed from specially annealed strip, formed while soft, and heat treated to obtain desired constant spring properties.

A special annealing technique was developed by Little Falls Alloys, suppliers of the strip, to provide a material having the necessary ductility together with full hardening response . . . in effect a "soft hardening" process.

To hold the attaching pressure with the desired limits, the individual spring tongues are heat treat formed.

This is a typical example of the exceptional accomplishments possible when the full potentialities of Be Cu^{mp} are applied to a difficult problem.

RELATIVE CORROSION-FATIGUE OF SPRING MATERIALS UNDER SALT SPRAY



Many materials that show good endurance life under normal alternating stress lose that advantage under corrosive conditions. The above chart shows the endurance limit of several spring materials at 50,000,000 cycles. The cross hatched area being the loss in endurance life when the test is repeated under salt spray. Note that only beryllium copper and phosphor bronze retained their full endurance strength under this corrosion-fatigue test.

FROM THE I-S LABORATORY

SPOT WELDING BERYLLIUM COPPER

Beryllium copper springs are spot welded easily, but the welding operation reduces the strength of the material at the point of the weld. To minimize the area of weakness, it is advisable to spot weld with a short time cycle. In general practice, it is preferable to weld after hardening, since it is difficult to heat treat the welded assembly.

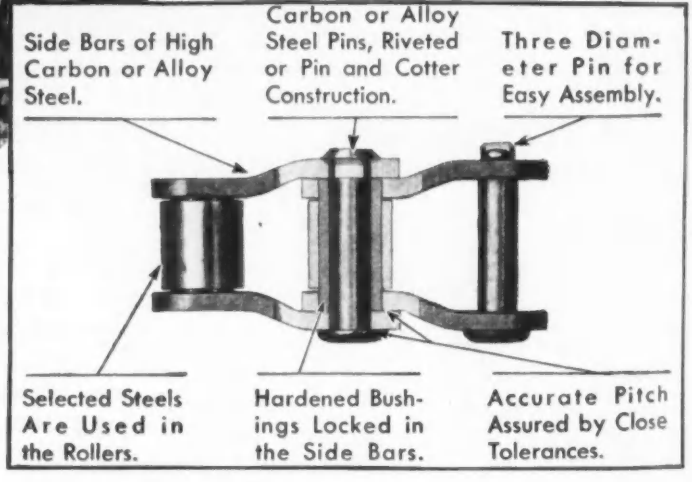
The shear strength of heat treated beryllium copper is 95,000 psi, while some measurements of the shear strength of spot welded points indicate a shear strength of 64,000 psi (this latter figure can be raised to 73,000 psi by proper heat treatment after welding).

This lowering of peak strength by spot welding makes it impossible to take full advantage of the high spring properties of beryllium copper if the welded area is at the point of peak stress concentration. It does make possible, however, the spot welding of contacts on the end of cantilever springs where the stress is lower.

IT GETS PUNISHED BECAUSE IT'S EXTRA GOOD!

① YES, HERE'S CHAIN BELT that's so extra good we recommend it for punishing service. Tough operating conditions . . . heavy loads . . . shocks . . . Rex Chabelco steel chain belts take them right in stride. They keep going long after ordinary chains are out of service.

② FOR TOUGH SERVICE CONDITIONS, the chain operation on this portable loader is hard to beat. Dust, grit, and shock loads really test a chain's mettle. But the Rex steel chain belts driving the elevator and carrying the buckets keep right on rolling . . . transmitting positive power and carrying the loads smoothly and efficiently. But what makes them so tough?


Side Bars of High Carbon or Alloy Steel.
Carbon or Alloy Steel Pins, Riveted or Pin and Cotter Construction.
Three Diameter Pin for Easy Assembly.
Selected Steels Are Used in the Rollers.
Hardened Bushings Locked in the Side Bars.
Accurate Pitch Assured by Close Tolerances.

③ HERE'S THE ANSWER. Take a good look at the cross-section of this Chabelco link. Note particularly the three-diameter pin. See how its milled flat end is locked in the side bar. Notice the offset side bar construction. Heavy force fits of precision machined parts result in the finest quality chains.

* * * *

Rex Chabelco steel chain belts are the answer to drive and conveyor problems where strength and long life are essential. The Rex Man will help you with your chain belt application problems. And for engineering data on Rex chain belts, ask for the 768-page catalog, No. 444. Chain Belt Company, 1715 W. Bruce St., Milwaukee 4, Wis.

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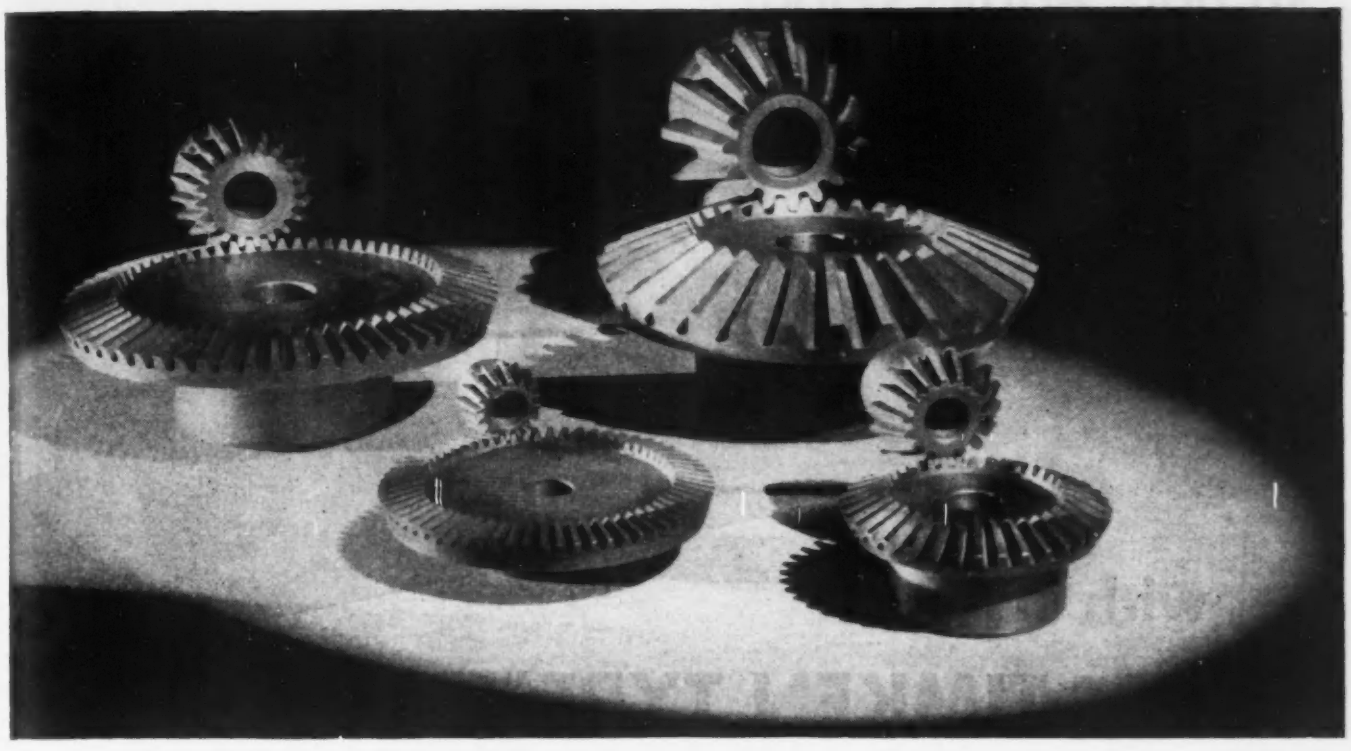
BEVEL GEARS



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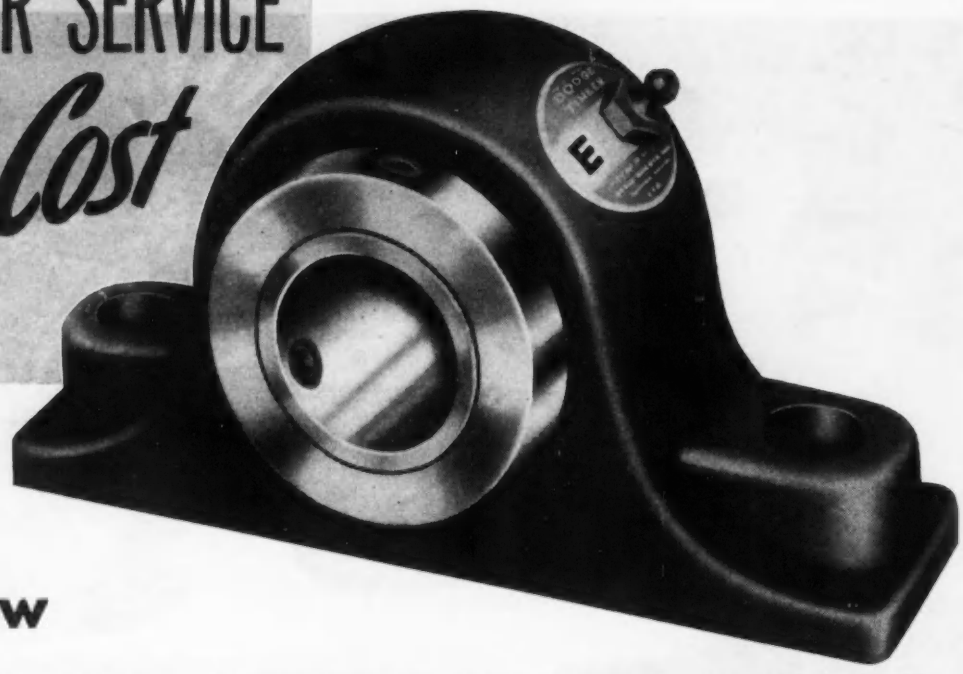

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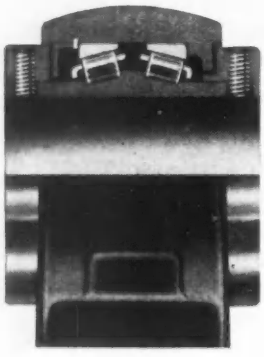

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Precision-built, rugged, dependable, the new Type "E" bearing assures 30,000 hours or more, of service, under conditions for which it is adapted. It offers superior load carrying and high speed capacity.

Type "E" bearings, completely assembled, lubricated and adjusted at factory, ready for immediate use, are available in Dodge distributors' stocks. Call the Dodge Transmissioneer in your territory for information about these, *and other new developments in power transmission equipment,* to help you increase production efficiency and lower your power costs.

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Sign of the Dodge Transmissioneer

DODGE
MISHAWAKA

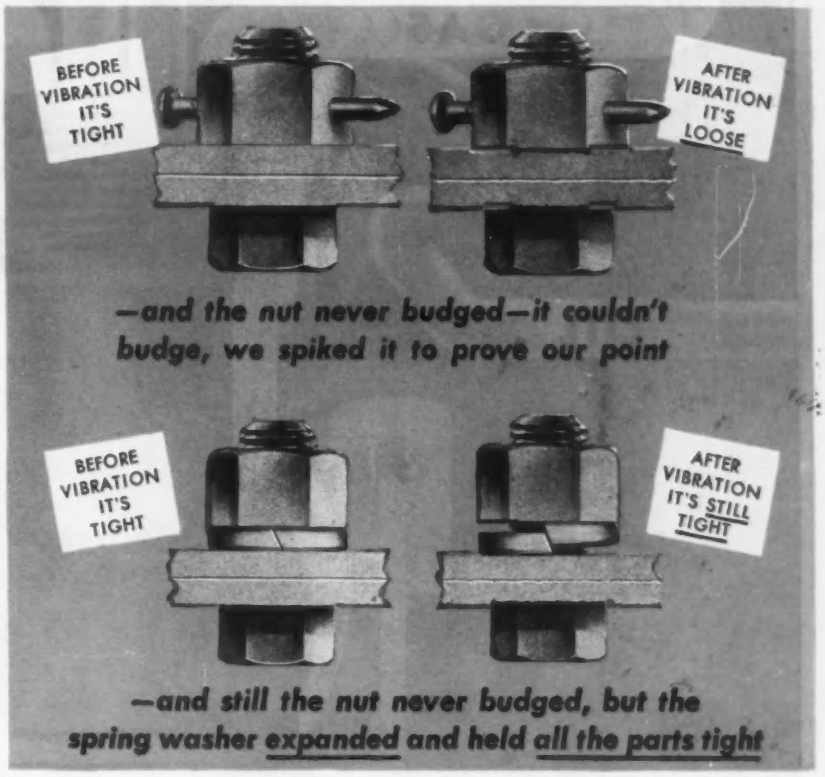
DODGE ROLLING BEARINGS . . . THE 30,000 HOUR LINE

TRANSMISSIONEERED MEANS ADVANCED DESIGN IN POWER DRIVES

Don't Let a Nut Mislead You

Even if the nut never budges on the bolt—all other parts of bolted assemblies inevitably loosen under vibration. Bolts stretch, metal rubs metal, rust and scale pulverize—all tending to loosen the entire assembly unless a strong spring washer is used to expand and hold all parts tight.

So whether you use a regular standard nut or one of the many fixed or lock-nuts you must use a powerful spring washer. The spring expands and compensates for later inevitable wear. No device except a long-range spring washer can expand and do this job that is so essential to bolted security.


BEFORE VIBRATION IT'S TIGHT
AFTER VIBRATION IT'S LOOSE
—and the nut never budged—it couldn't budge, we spiked it to prove our point
BEFORE VIBRATION IT'S TIGHT
AFTER VIBRATION IT'S STILL TIGHT
—and still the nut never budged, but the spring washer expanded and held all the parts tight

Our Kantlinks conform to Government Specifications BECX 1-2-3, AN 935, and drawing 12-Z-22.

Originators of KANTLINK the long-range spring washer

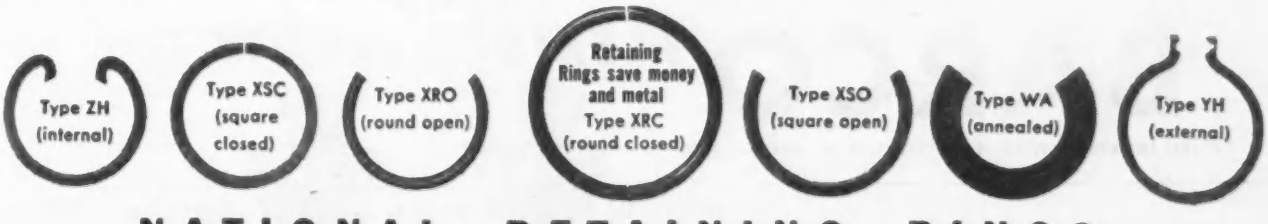
NATIONAL LOCK WASHER COMPANY

NEWARK, N. J., U. S. A.

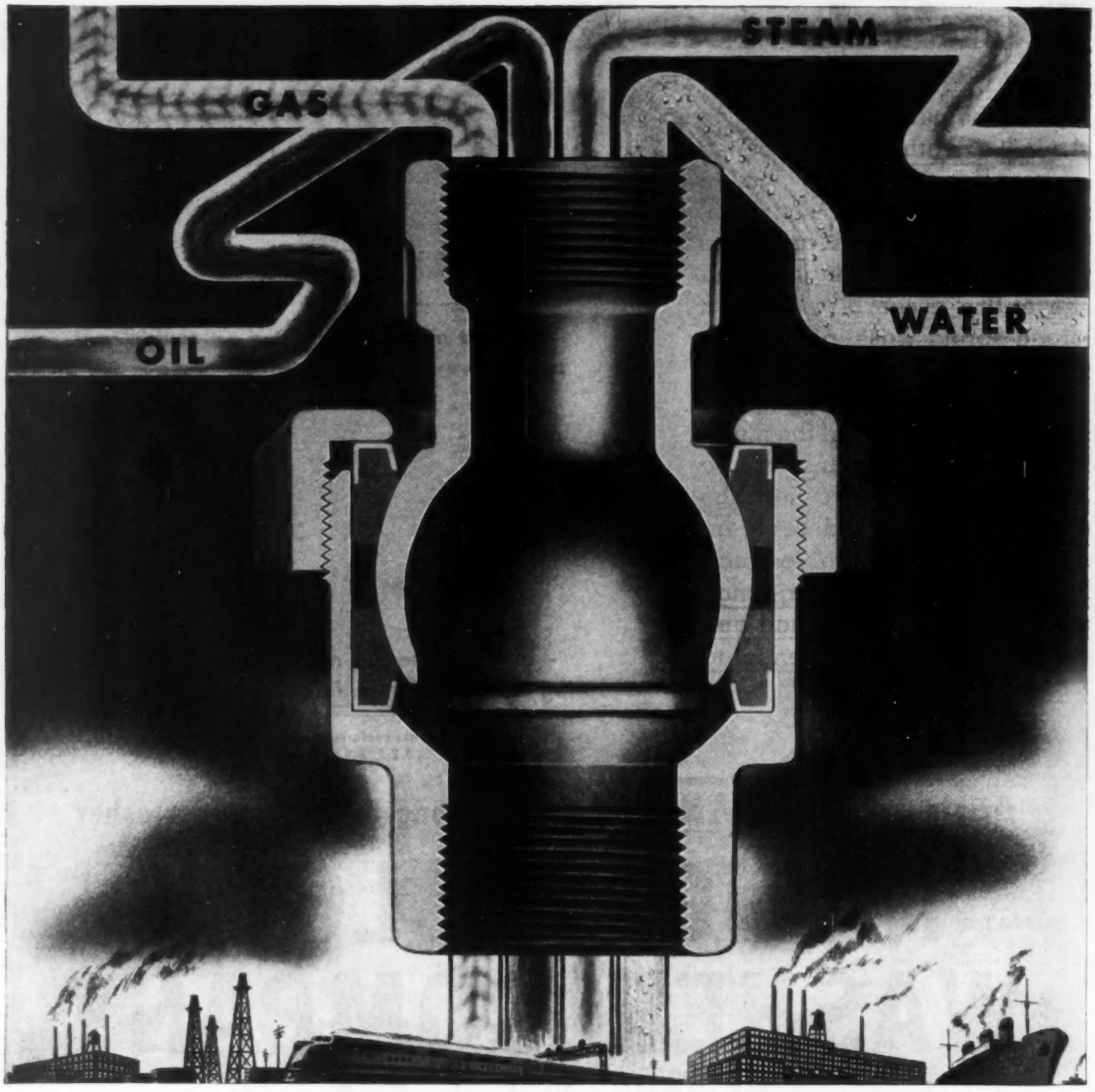
YOU CAN NOW BUY EFFICIENT, YET INEXPENSIVE RETAINING RINGS THAT SAVE METAL AND MONEY FOR YOU

These artificial shoulders are used more and more widely to hold many types of mechanisms in place. They are less expensive than big shoulders, and more efficient also than cotter pins, etc.

Examine your machines and metal products to see where retaining rings can save you dollars and metal.



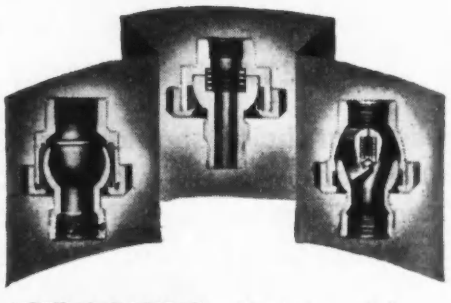
NATIONAL RETAINING RINGS



BARCO KEEPS VITAL FLUIDS FLOWING

The destructive action of vibration and shock can't hurt fluid-conveying pipes protected by Barco Flexible Joints. By means of responsive movement, Barco compensates for every contraction and expansion—preventing leaks and breaks. Its range of designs covers every flexible joint problem in transportation and industry. Today, as in the past 30 years, Barco's experience and progressive skill stand ready to assist you. Barco Manufacturing Co., Not Inc., 1800 Winnemac Avenue, Chicago 40, Illinois.

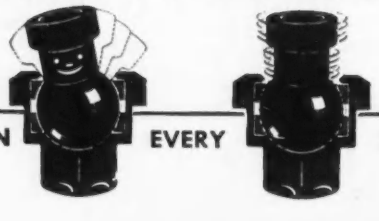
In Canada: The Holden Co., Ltd., Montreal, Canada



BARCO FLEXIBLE JOINTS

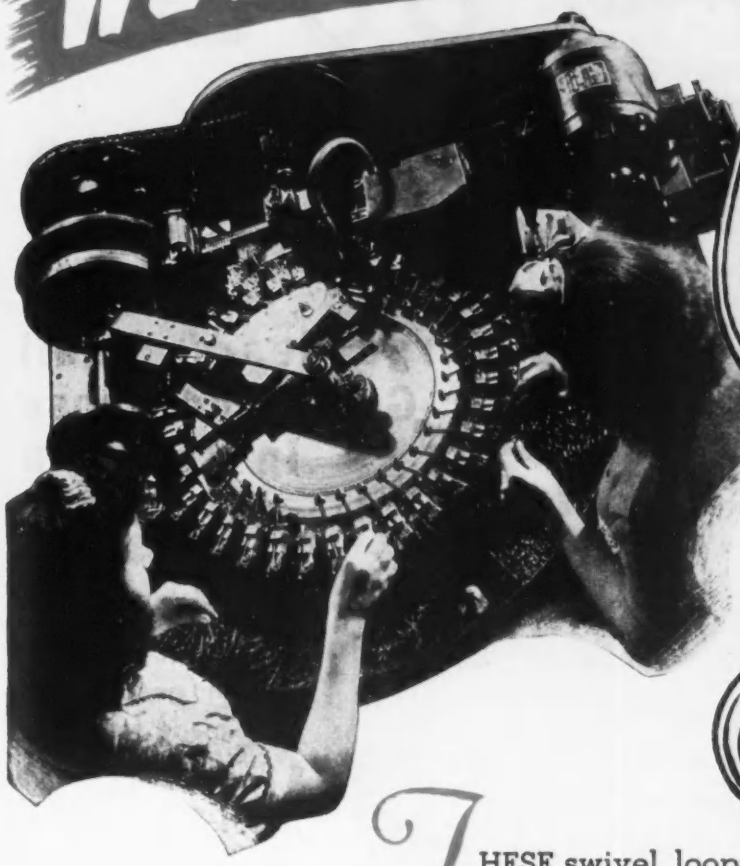
THE FREE ENTERPRISE SYSTEM IS THE SALVATION OF AMERICAN BUSINESS

Not just a swivel joint...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.



"MOVE IN EVERY DIRECTION"

WE'VE TURNED THEM OUT *by the* MILLIONS



THESE swivel loops are essential to certain devastating projectiles. Here at Accurate, special forming and testing equipment were designed and built to produce them in the vast quantities needed, and to the rigid specifications required.

Perhaps you will never need a swivel loop for your product. But, whether it's swivel loops, special wireforms or springs, Accurate experience and ability is at your service. Your products of tomorrow, as well as of today, are our interest. We want to help you produce them better, faster, for less.

Send for your copy of the new Accurate Spring Handbook. It's full of data and formulae which you will find useful. No obligation, of course.

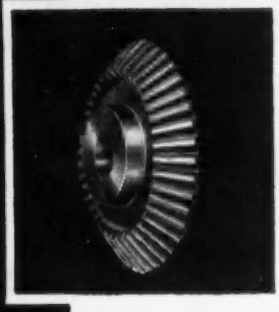
WIRE FORMS
SPRINGS
STAMPINGS

Accurate Springs

ACCURATE SPRING MFG. CO., 3815 W. Lake St., Chicago 24, Ill.

Brad Foote Gears

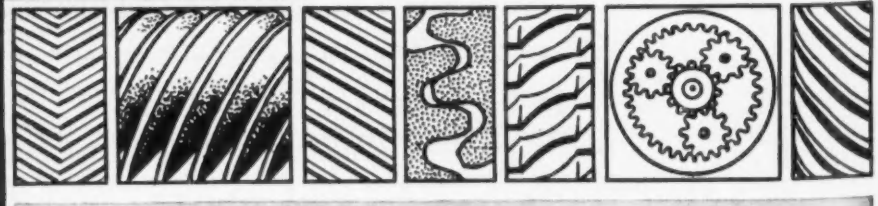
Large Gears, Small Gears and Those In Between



It's all the same at the ultra-modern Brad Foote Plant, where special precision-cut gears have been made for over a generation.

The extensive equipment of this plant permits the manufacture of unusually large amounts of smooth running quality precision-cut gears in all tooth forms from any practical material.

Brad Foote special cut gears have met the test and are doing their bit.

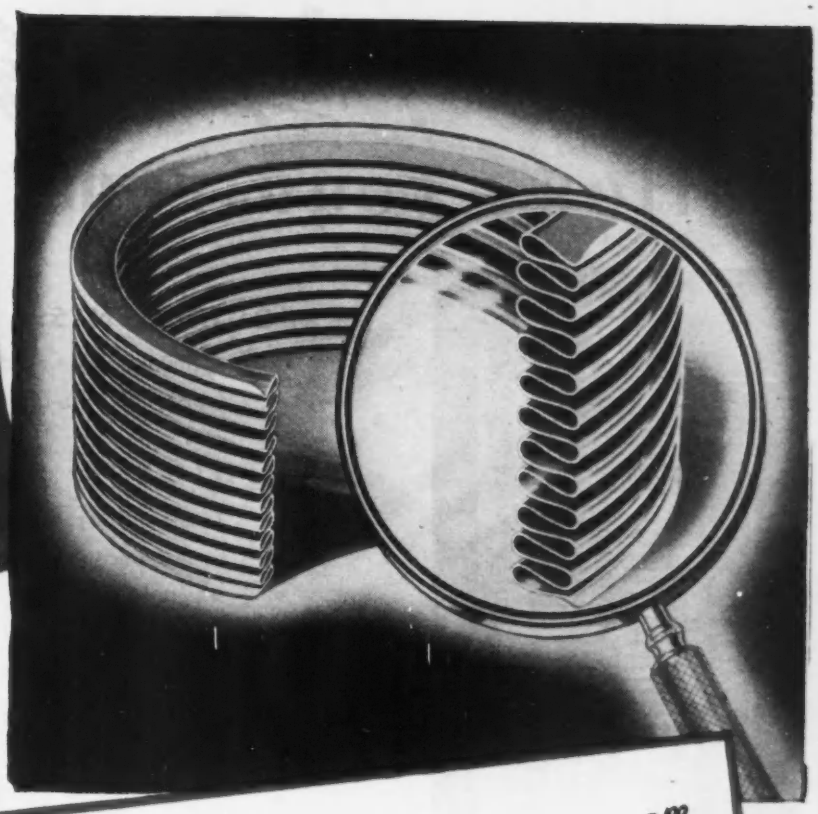


Brad Foote Precision cut bevel gears

BRAD FOOTE GEAR WORKS

1309 S. CICERO AVENUE CICERO 50, ILLINOIS

Question: How long will it last?



ANSWER:

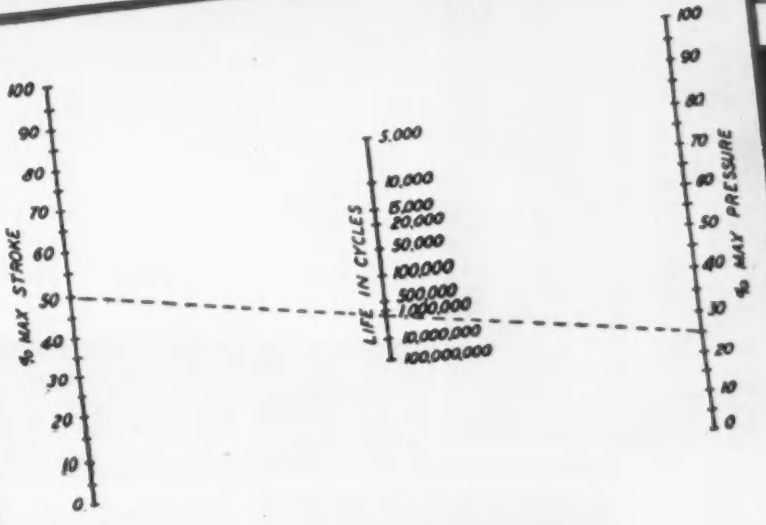
Using a straight edge, connect the stroke expressed in percentage of the maximum stroke and the pressure expressed in the percentage of the maximum pressure. This line intersects the central scale at the probable life.

Example: A 1½" O.D. bellows (listed on page 11, line 56) having 14 active convolutions, is to operate making 0.2051" stroke under 42.5 lbs. per sq. in. pressure. What will be its probable life?

Percent of Maximum Stroke = 50% (0.2051 ÷ 0.4102 = 50%. See columns 4 and 7, page 11).

Percent of Maximum Pressure = 25% (42.5 ÷ 170 = 25%. See column 10, page 11).

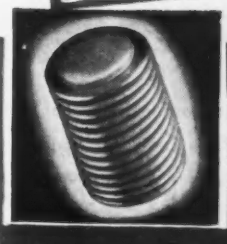
A line connecting 50% stroke and 25% pressure intersects central scale at more than 1,000,000 cycles. This figure is the probable life under the stated conditions.



SERVICE LIFE EXPECTANCY CHART

The chart above shows the relation between stroke, pressure and life. It is based on results of hundreds of tests conducted on various sizes and types of bellows under many different conditions and affords a method of predicting bellows life expectancy.

EXCERPT: Above chart is taken from new Bridgeport Bellows catalog CP-100 This valuable reference book sent upon request. Includes information which should be in every data file.



Bellows Assemblies . . . Bellows . . . Bellows Devices

BRIDGEPORT THERMOSTAT COMPANY, INCORPORATED—BRIDGEPORT 1, CONN.

Only "Spring-life" can meet Bellows requirements like this

REQUIREMENTS:

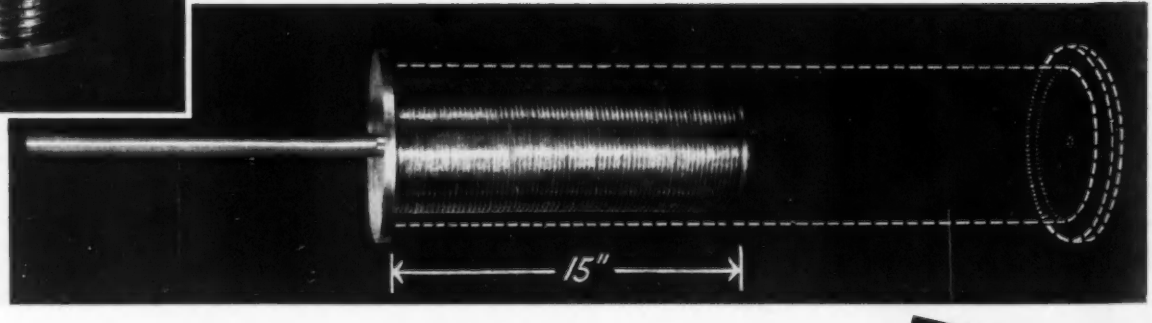
A bellows to be used as a piston within a cylindrical housing 30" long by 6½" O.D. to give a displacement of a minimum of 240 cubic inches.

FULFILLMENT:

To meet this requirement, a "Spring-life" bellows 5⅞" O.D., made of tinned phosphor bronze with 68 flanges or convolutions, was constructed. The free length of this bellows is 25". In order to satisfy the requirement of 240 cubic inches displacement, this bellows must travel 15". This is accomplished by extending the bellows 5" from its free length and compressing it 10" from its free length. The drive shaft is made of stainless steel rod and is guided internally on a stainless steel tube. Life expectancy of this unit is 300 million flexures at the rate of 50 per minute, or a total of 19 years continuous operation without undue surges and when operated within its elastic limits.

Here is another example of what was an unusually difficult problem until Cook engineers solved it and added another page to their file of "impossible" jobs accomplished.

Many of the largest manufacturers in the country consistently "Look to Cook" to solve their unusual problems. They have learned that we do not tolerate the word "can't." This attitude of the Cook engineering staff can be of service to you.



This book will give you the complete story of the 7 advantages of "Spring-life" construction

COOK ELECTRIC Company

"Spring Life" Engineered Bellows in Sizes from Midget to Giant

2700 SOUTHPORT AVENUE · CHICAGO 14, ILLINOIS

Here is a new book just off the press that contains the complete story of the Cook "Spring-life" idea, its history, its advantages, its applications, and complete data for specifying and ordering Cook "Spring-life" Bellows.

If you will need

PISTON PINS

or other parts such as spindle bolts, ball bearings, knuckle pins, clutch plates, etc.

for products like these...

Our plant facilities and experienced manpower belong in your picture...

Before the war Burgess-Norton was one of the leading suppliers of piston pins to the automotive, farm equipment, compressor, marine and diesel industries. Now, with enriched production know-how and facilities resulting from war production of these parts for America's war machine, Burgess-Norton will have even more to offer. Unchanged, however, will be our 40 year ideal: "To endeavor to function on every assignment as though we were a part of the organization being served."

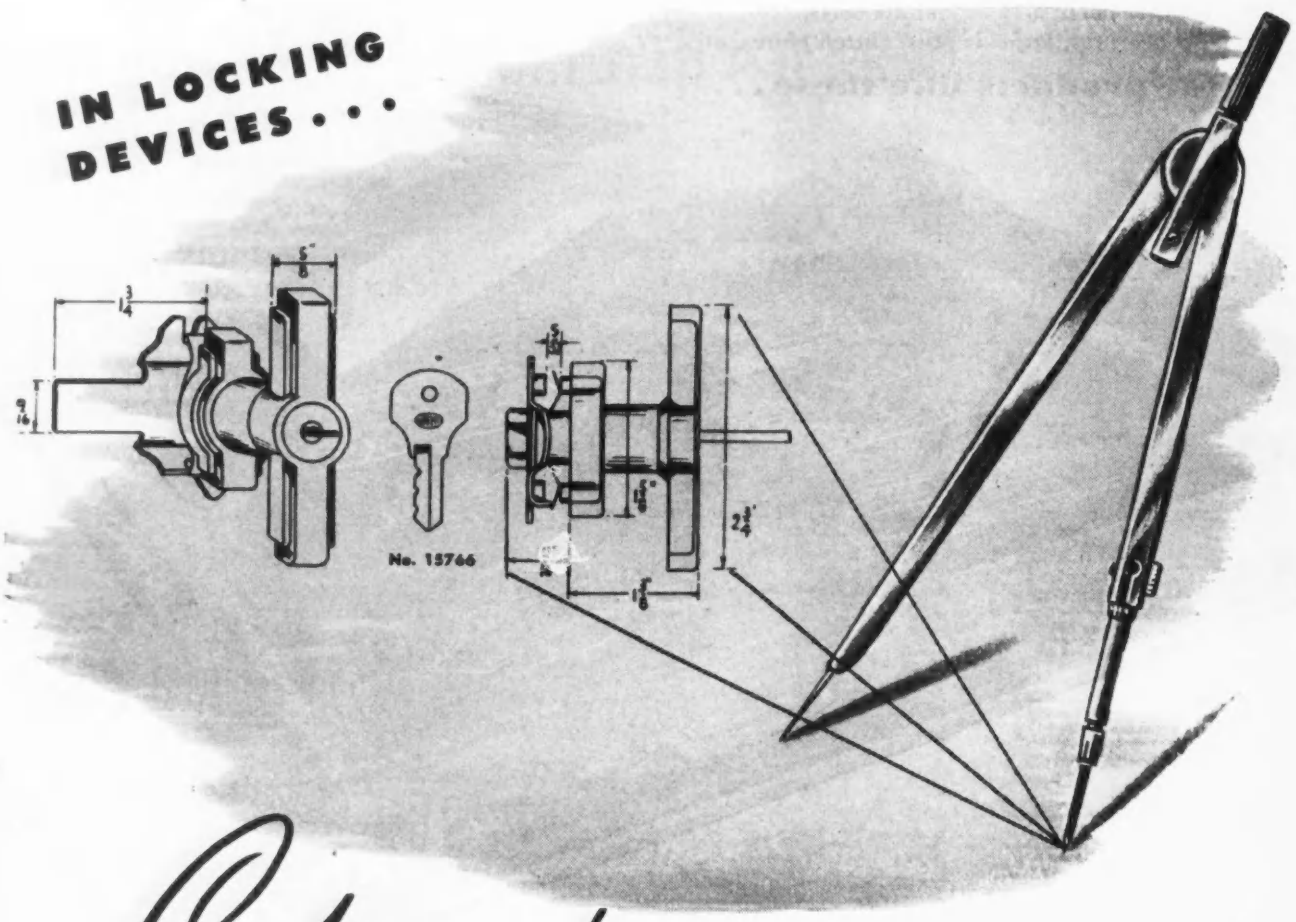
Let's talk it over...

Write for the Free Booklet on our facilities for the production of piston pins; ball bearings; hardened and ground screw machine parts; heat treated and hydrogen copper brazed steel stamping or forging assemblies. Burgess-Norton Mfg. Co., 200 Peyton Street, Geneva, Illinois.

Burgess Norton
MANUFACTURING COMPANY
40 years in GENEVA, ILLINOIS

A Part is Never Made Right Unless it is Satisfactory to Our Customers

IN LOCKING DEVICES . . .



Craftsmanship TO MATCH YOUR DESIGN!

● When you're working "from scratch"... or the design calls for appreciative understanding or subtle treatment... let Corbin transfer the job from your drafting board to the finished product. Sixty-three years of working cooperatively with design engineers has taught us much that saves time, steps up quality and assures *definite* attainment of the objective.

If a stock design is to be specified, our "Industrial Catalog" is a profitable source for locking devices that do much more than merely "fill the bill." Or in particular cases, you may prefer to send a blueprint—or have a Corbin Lock engineer call. Let us know your requirements.

CORBIN

CORBIN CABINET LOCK CO.

NEW BRITAIN, CONNECTICUT

THE AMERICAN HARDWARE CORPORATION, SUCCESSOR

"Safety first....and last....when Corbinlocked"

For effective Fluid Power Systems

If you have mechanical operations to get done with efficiency and economy, consider Fluid Power.

It is the modern way to transmit power from its source to its job—without shafts, gears, belts or levers.

It moves wherever you want it to go through tubes, and is controlled by valves.

Your Fluid Power system will deliver sure and dependable performance, under all conditions, if it is

Engineered by **PARKER**

THE VITAL LINK

in Fluid Power is the Circuit. It goes around corners and into tight places. It must be proof against leak, shock and vibration, and must be pressure-tight.

Parker brings twenty years of experience to the engineering of this Vital Link. We build the valves and fittings, and the tools to handle them.

This specialized "know-how" is yours to command. . . .

You'll find it worth-while to talk with a Parker Fluid Power Engineer. Write to The Parker Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

THE PARKER APPLIANCE COMPANY

CLEVELAND — LOS ANGELES

FLUID POWER ENGINEERING

Send YOUR BOLTING SPECIFICATIONS *to a Specialist*

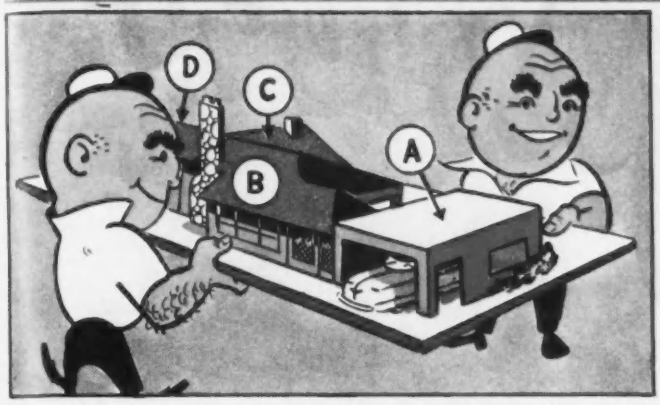
IT IS YOUR RESPONSIBILITY, ***as a Farm Machinery Builder, to design and produce the best equipment that can be manufactured. In designing high quality equipment you will need many special bolts and studs. Our plant, from carbon and alloy steel storage to final testing, is especially geared to high quality manufacture. In these critical times it is essential that you consult a specialist with many years of specialized bolting experience to offer. Write us today.***

ERIE BOLT & NUT CO.

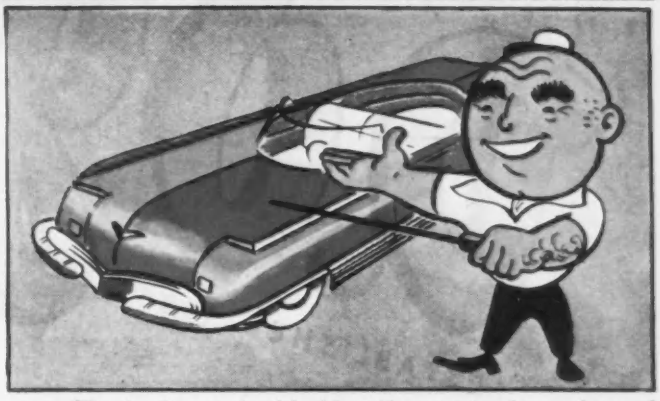
ERIE, PA.

STUDS • BOLTS • NUTS ~ ~ ALLOYS • STAINLESS • CARBON • BRONZE

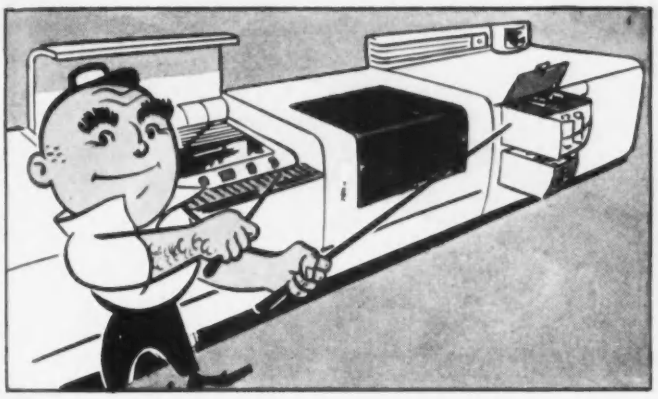
BUNDYWELD IN EVERY HOME



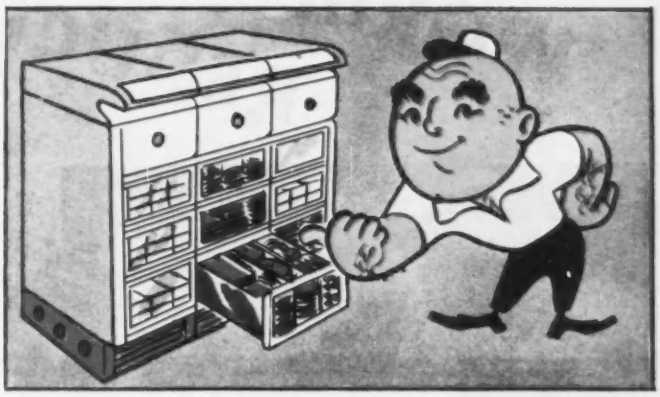
THE MODERN American home is served with many appliances and conveniences equipped with Bundy steel tubing . . . appliances and conveniences which give the American family the highest living standard in the world.



A The family car (and incidentally most trucks on the road, too) may have an average of twenty Bundyweld parts—fuel lines, oil lines, brakes tubes, and many miscellaneous small parts.

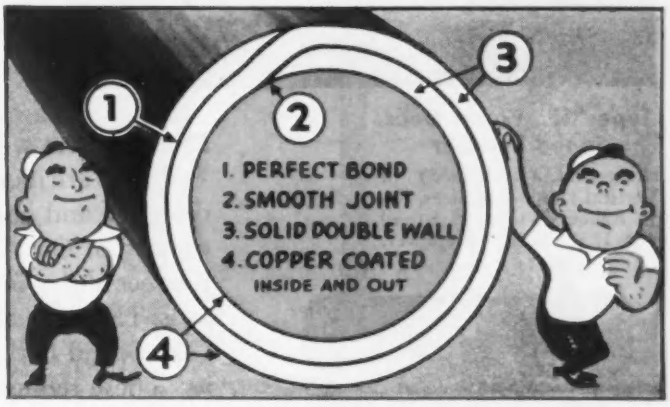


B In the kitchen, the gas range probably has flash tubes, pilot lines, and connecting tubes of Bundyweld. And for the electric refrigerator's condenser, Bundyweld is pretty much standard throughout the entire industry.



C Wherever the food freezing and storage unit may be—basement, utility room, or a complete separate room, it, too, may have many Bundyweld Tubing parts similar to those in the electric refrigerator.

D Water and space heating units are apt to use Bundyweld for pilot lines, connector and feeder tubes—in fact anywhere a tube in Bundy's range of sizes is required.



ALL THESE USES are not just accidental. They are because industry recognizes that the solid, double wall construction of Bundyweld—an exclusive Bundy feature—meets every test for superior performance.

BUNDY TUBING

ENGINEERED TO YOUR EXPECTATIONS

BUNDY TUBING DISTRIBUTORS AND REPRESENTATIVES:

Pacific Metals Company, Ltd. 3100 19th Street San Francisco 10, California	Standard Tube Sales Corp. 1 Admiral Avenue Maspeth, New York City, N. Y.	Lapham-Hickey Company 3333 W. 47th Place Chicago 32, Illinois	Rutan & Company 112 South 16th Street Philadelphia 2, Pennsylvania	Eagle Metals Company 3628 East Marginal Way Seattle 4, Washington

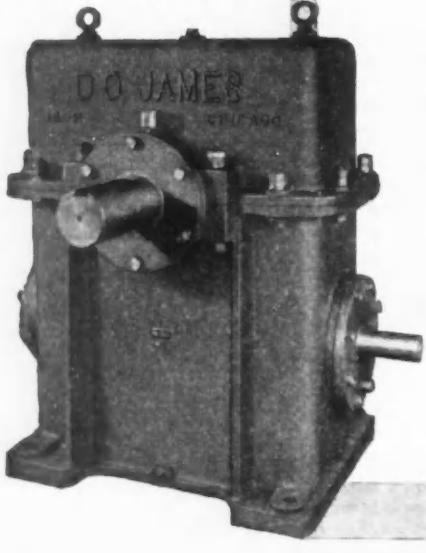
D. O. James

ESTABLISHED 1888

WORM GEAR REDUCERS

Type "H" Worm Gear Speed Reducer

Horizontal (Illustrated) or Vertical Drive—26 Sizes, Ratio Range of 6 to 65:1, and from 1/32 to 150 Horsepower.



Designed and Built for the Successful "Doing of The Job"—

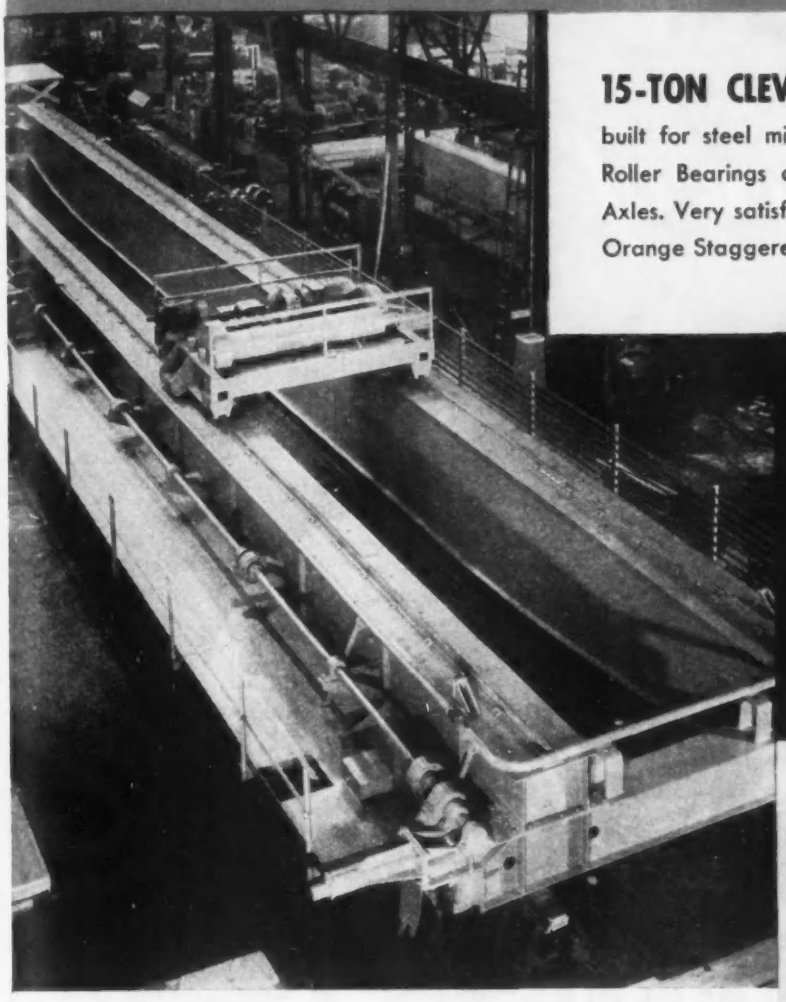
Due to their wide ratio range, the D. O. James Worm Gear Reducers are ideal for many power saving installations. They are designed and built by an organization that has had over a half century of Gear Making Experience and who have successfully pioneered the Gear Reducer to its present high efficiency standards. The many and repeated installations of D. O. James Worm Gear Speed Reducers testify to their superiority and adaptability. These reducers are the result of excelling craftsmanship in our engineering, cutting, grinding, assembling, inspection and testing departments. Their efficiency is further increased in the usage of the best and most suitable materials. An experienced supervision and modern plant facilities assure a finished product that will be successful in "The Doing of The Job."

D. O. JAMES MANUFACTURING CO.

4417 Roosevelt Road • Chicago, Illinois

Makers of Every Type of Gear and Gear Reducer

DESIGNED FOR HEAVY LOADS!



15-TON CLEVELAND OVERHEAD CRANE

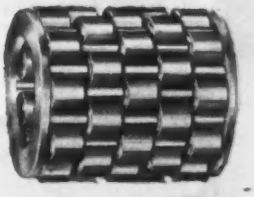
built for steel mill service, uses Orange Staggered Roller Bearings on Hoist Shaft and Bridge Wheel Axles. Very satisfactory service is reported wherever Orange Staggered Roller Bearings are used.

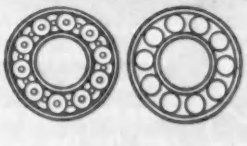
ORANGE "STAGGERED" ROLLER BEARINGS

Wherever bearings of extreme ruggedness and load carrying capacity are needed in your equipment—be sure to study the capacities of Orange Staggered Roller Bearings when designing. You'll find that you can design to smaller size, because Orange Staggered Roller Bearings do the work of larger conventional roller bearings. Or, use them equal size for higher load carrying, safety margin and life hours expectancy.

The exclusive design of Orange Staggered Roller Bearings (shown at the right) shows how the load is distributed over many short rolls instead of a few full length rolls. Maximum supporting area is obtained in minimum space. Skewing of rollers is minimized due to the ease of alignment and adjustment in the raceway load area. Even running is assured.

Orange Staggered Roller Bearings are made in a full range of standard, **interchangeable** sizes. Write for Engineering Data Book giving details of design, sizes, capacities, application data, etc.





The staggered roller design brings maximum roller surfaces in contact with the load, as shown by end views of an Orange Staggered Roller Bearing and a conventional roller or ball bearing.

Mail Coupon for Engineering Data

Orange Roller Bearing Co., Inc., P.E.
Orange, N. J.

Please send me your Staggered Roller Bearing Data Book

Name..... Title.....

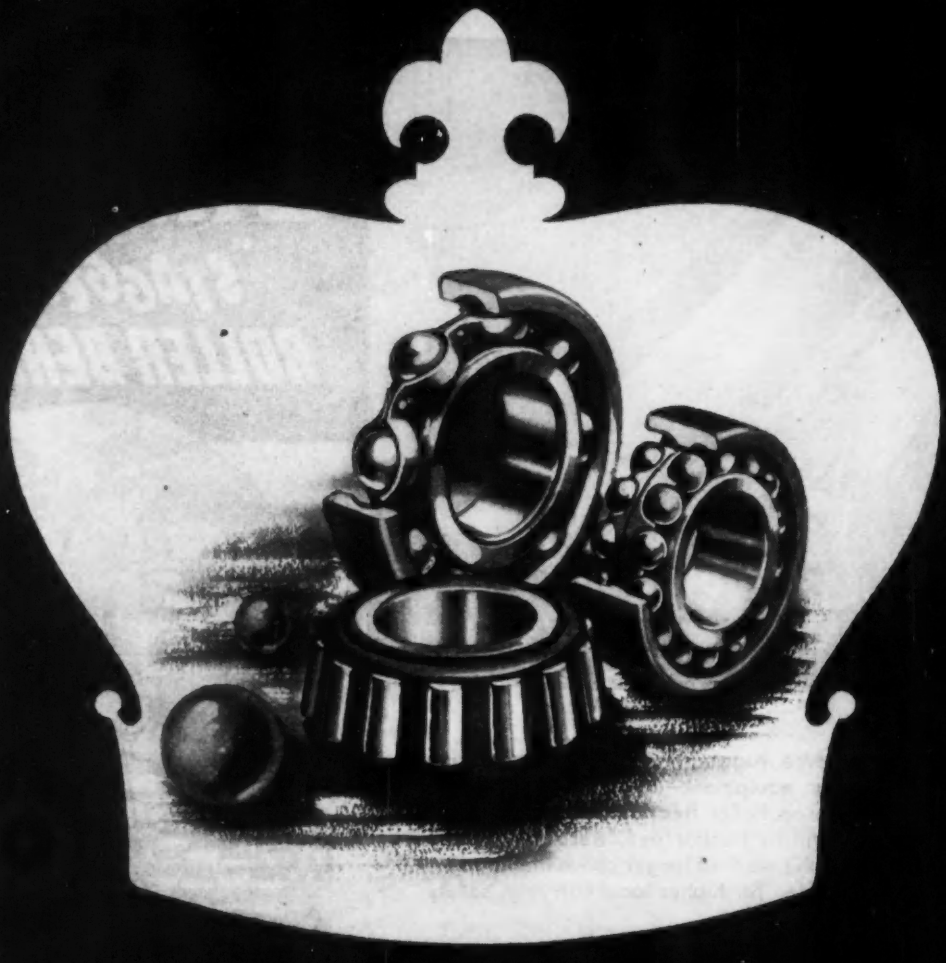
Company.....

Address.....

City..... State.....

ORANGE ROLLER BEARING CO., INC.
551 Main Street, Orange, N. J.

Excellence of Design



Hoover, the Aristocrat of Bearings, are of the Super-Conrad Deep Groove Type employing the largest size and greatest number of balls. This type of bearing, plus the added advantage of Hoover's exclusive honed raceways has been proved, by actual test, to be the most universally dependable for the varying conditions of load and speed under which modern machines operate.

HOOVER

BALL AND BEARING COMPANY, ANN ARBOR, MICHIGAN

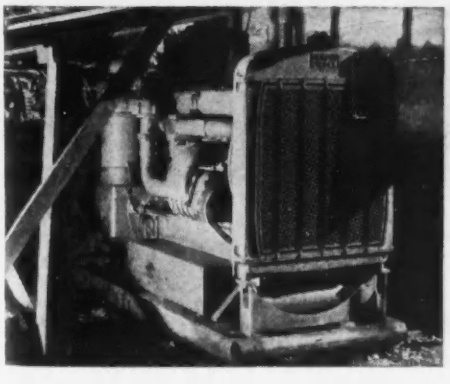
SUPERCHARGING made this power Portable

PRODUCING 125 tons of hot-mix an hour, for resurfacing Highway 10, near Frenchtown, Mont., this asphalt plant required more power than an ordinary portable generator could supply.

Today this plant is operating on a single-unit, self-contained Murphy Diesel Generating Set, supercharged by B-W. Weighing only approximately 9,000 pounds, the unit supplies 106 Kilowatts and is easily manageable on a heavy truck.

To provide more power in a given space or weight . . . or to compensate for loss of power at higher altitudes . . . and with little appreciable increase in weight — B-W Supercharging finds many uses in engines for the marine, industrial, transportation, and automotive fields.

This Murphy Diesel Generating Set, supercharged by B-W, is producing 106 kilowatts. The actual size of the unit is only 11 feet long, 40 inches wide, and 5 feet 6 inches high.

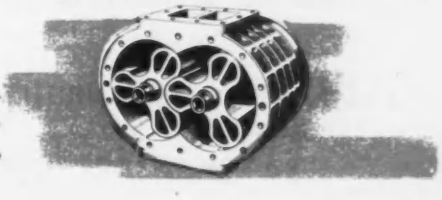


ENGINEERING B-W PRODUCTION

SUPERCHARGERS, INC.

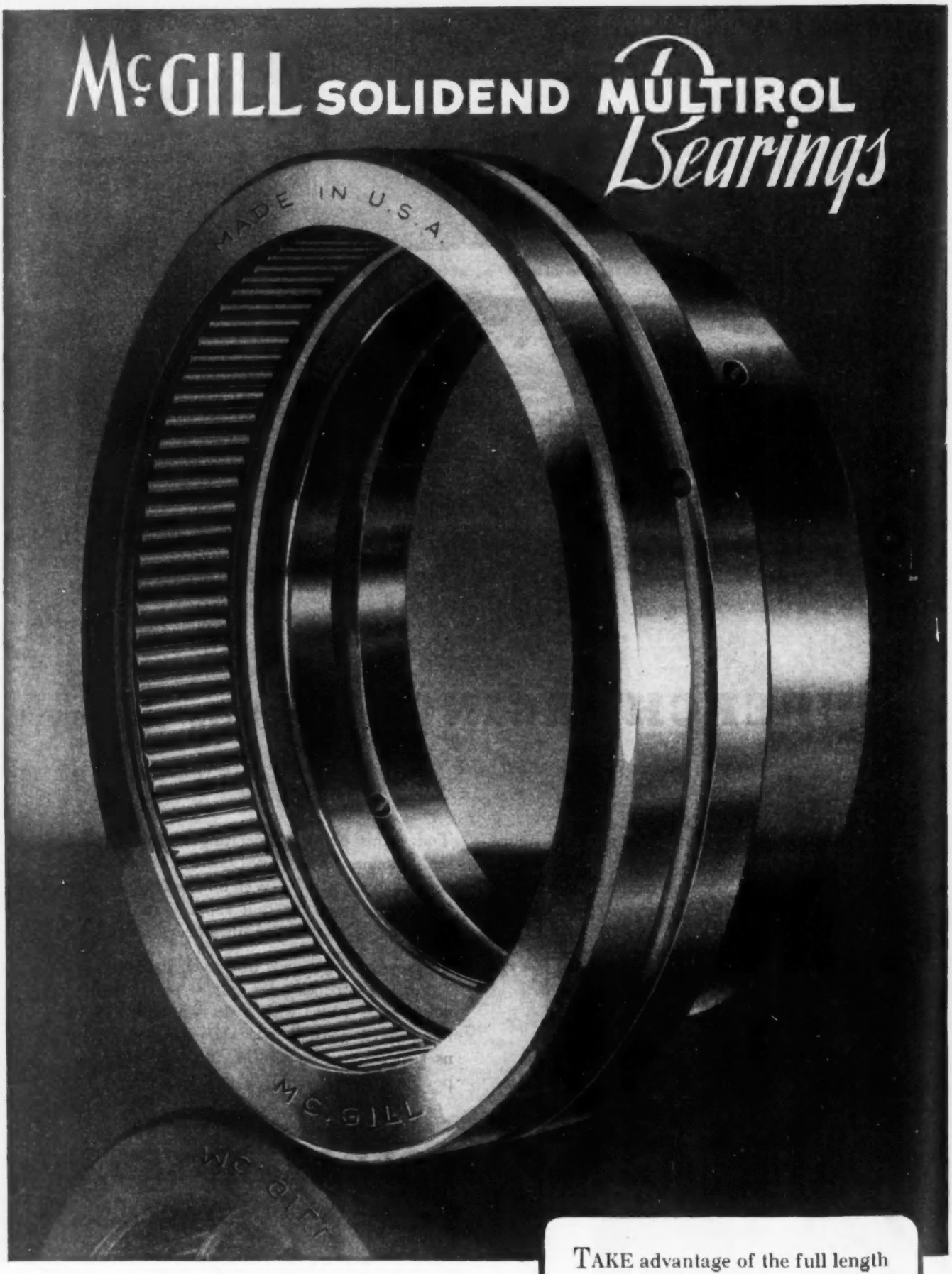
DIVISION OF BORG-WARNER

Milwaukee 9, Wisconsin



B-W Superchargers are precision-built for the most efficient operation and long, trouble-free service.

McGILL SOLIDEND MULTIROL Bearings



TAKE advantage of the full length rollers of McGILL "Solidend" *MULTIROL* Bearings. We will be glad to send you our catalog SM-42.

McGILL MANUFACTURING COMPANY, INC.
Manufacturers of Ball and Roller Bearings
VALPARAISO, INDIANA

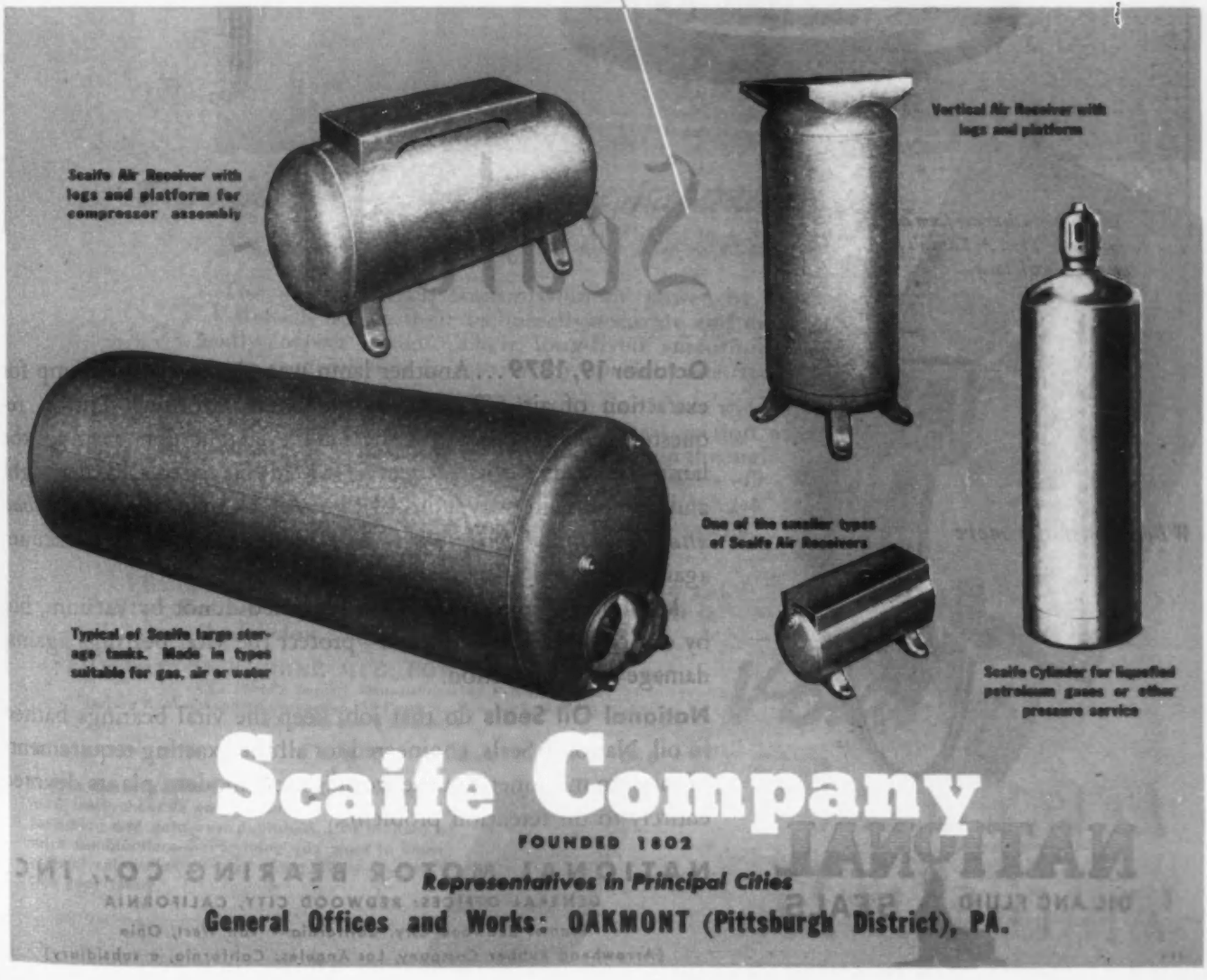
SCAIFE PRESSURE VESSELS

FIT YOUR PLANS!

FIT YOUR PURSE!

You can save time and money—and get exactly what you want—by buying tanks, cylinders and pressure vessels from Scaife. Naturally, you have rigid specifications that must be met—and you insist on absolute dependability and reliability. Scaife can give you these qualities, and perhaps suggest changes that will reduce costs, improve the product or otherwise react to your advantage.

We have had extensive experience in the design, manufacture and use of pressure vessels of many types. Make use of this experience by having Scaife make *your* pressure vessels.

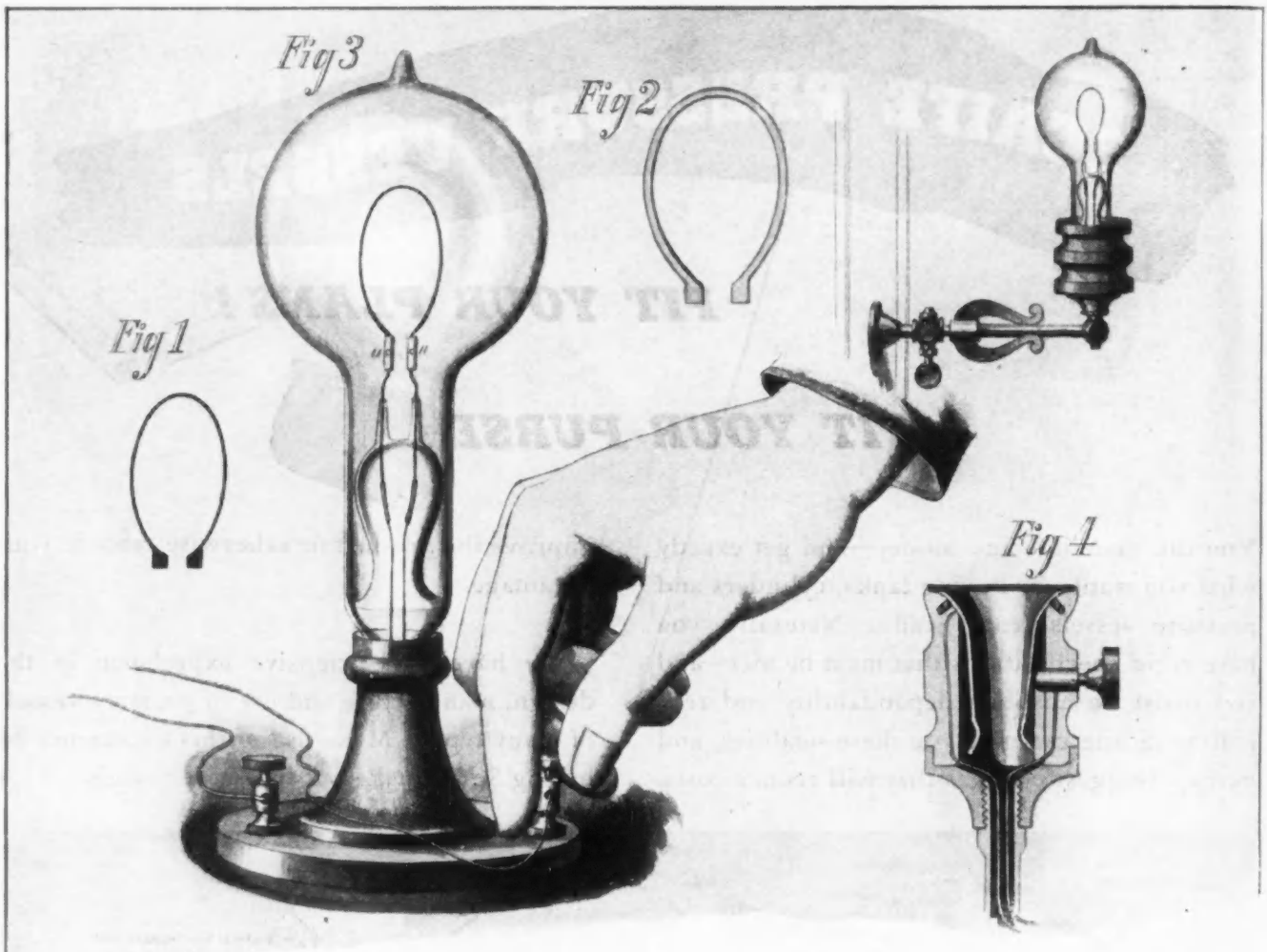

Scaife Air Receiver with legs and platform for compressor assembly
Vertical Air Receiver with legs and platform
Typical of Scaife large storage tanks. Made in types suitable for gas, air or water
One of the smaller types of Scaife Air Receivers
Scaife Cylinder for liquefied petroleum gases or other pressure service

Scaife Company

FOUNDED 1802

Representatives in Principal Cities

General Offices and Works: OAKMONT (Pittsburgh District), PA.



These illustrations are from early drawings of Thos. A. Edison's first successful electric lamp.

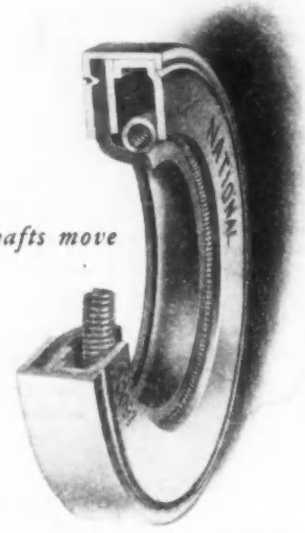
Sealed---

October 19, 1879... Another lamp was placed on the pump for extraction of air...Then, with pump still working, Edison requested Boehm to seal off the bulb. At eight that evening, the lamp was ready for its life test... It held out heroically that night and the following day, until by two o'clock that afternoon, *it had attained a life of forty hours!!* The filament sealed in a vacuum against destruction by oxygen of the air.

Modern machines, too, must be sealed... not by vacuum, but by devices that seal in the oil—protect the vital bearings against damage and destruction.

National Oil Seals do that job; keep the vital bearings bathed in oil. National Seals, engineered for all the exacting requirements of modern machinery, in the world's most modern plants devoted entirely to oil retention problems.

Wherever shafts move



NATIONAL
OIL AND FLUID **SEALS**

995

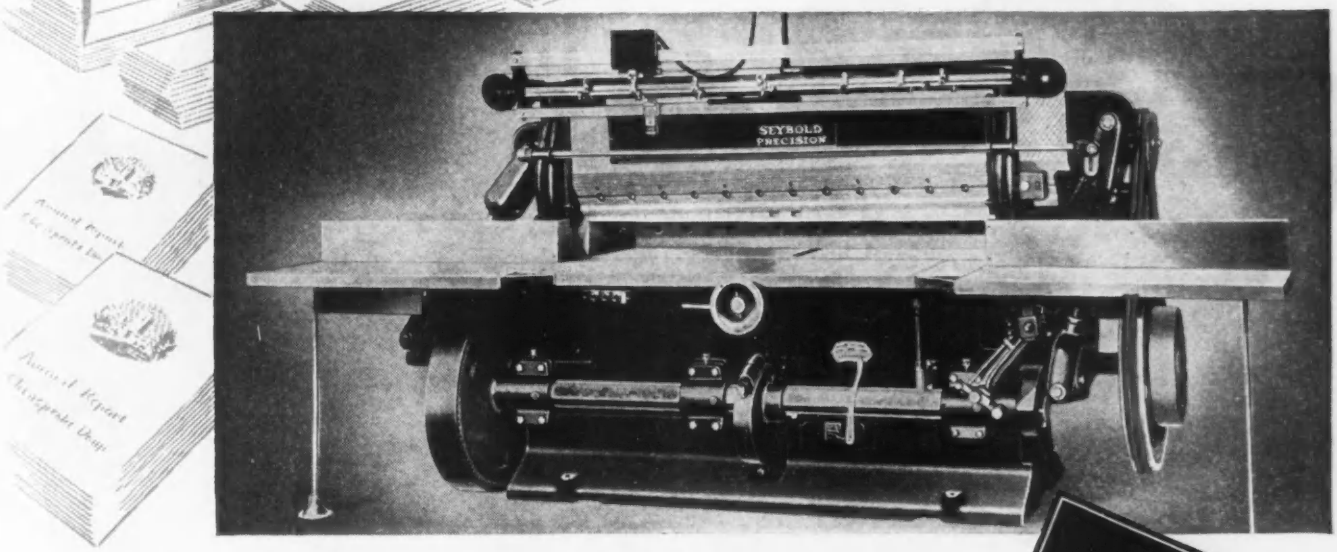
NATIONAL MOTOR BEARING CO., INC.
GENERAL OFFICES: REDWOOD CITY, CALIFORNIA
Plants: Redwood City, California • Van Wert, Ohio
(Arrowhead Rubber Company, Los Angeles, California, a subsidiary)

Dayton V-Flat Drives chosen for machines made to handle

28,000 lb. Shock Loads

MASSIVE CONSTRUCTION, PRECISION ACCURACY, AND FAST, DEPENDABLE OPERATION characterize the paper and press-board cutting machines made by the Harris-Seybold-Potter Company. Heavy lifts of paper stock and various fibrous materials are often tough to cut. So this equipment is designed to give its knife a cutting force up to 28,200 lbs . . . almost 15 tons.

At every cut a tremendous shock occurs, especially to the power-transmission equipment. Only two Dayton V-Flat Belts handle this load "very satisfactorily . . . giving long, trouble-free service, and requiring surprising minimums of adjustment," says the company.



Dependable grip of Daytons maintained by ELIMINATION OF "STRETCH"

The sturdy, FULL transmission of power by Dayton V-Belts is due to their technically-accurate and mechanically-correct design. Their long-lived smoothness of power transmission is assured by special construction.

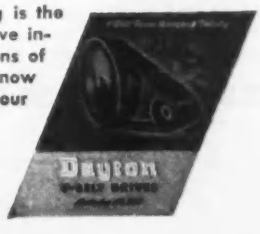
Famous "STRETCHLESS" Daytex Cords are welded, under tremendous tension, into the neutral section of every Dayton V-Belt. It enables Daytons to retain throughout their amazingly long life their unusually high efficiency. These are qualities of Dayton V-Belts which have established Dayton Rubber as the largest V-Belt manufacturer in the world.

FREE, for merely sending in your inquiry, you get Dayton Rubber's complete new V-Belt Handbook. It is fully described below. Send for it, get yours, today.

THE DAYTON RUBBER MFG. COMPANY, DAYTON 1, OHIO
The World's Largest Manufacturer of V-Belts
Dayton Rubber Export Corporation, 38 Pearl St., New York, N. Y., U. S. A.
Cable Address: WIDBLOCO

KEEP ON BUYING WAR BONDS

Dayton Rubber's new 384-page V-Belt Catalog is the most comprehensive encyclopedia of V-Belt Drive information and data ever published. Lists millions of drive combinations—everything you want to know without calculation or engineering. Write for your free copy today.



V-Belts by

Dayton Rubber

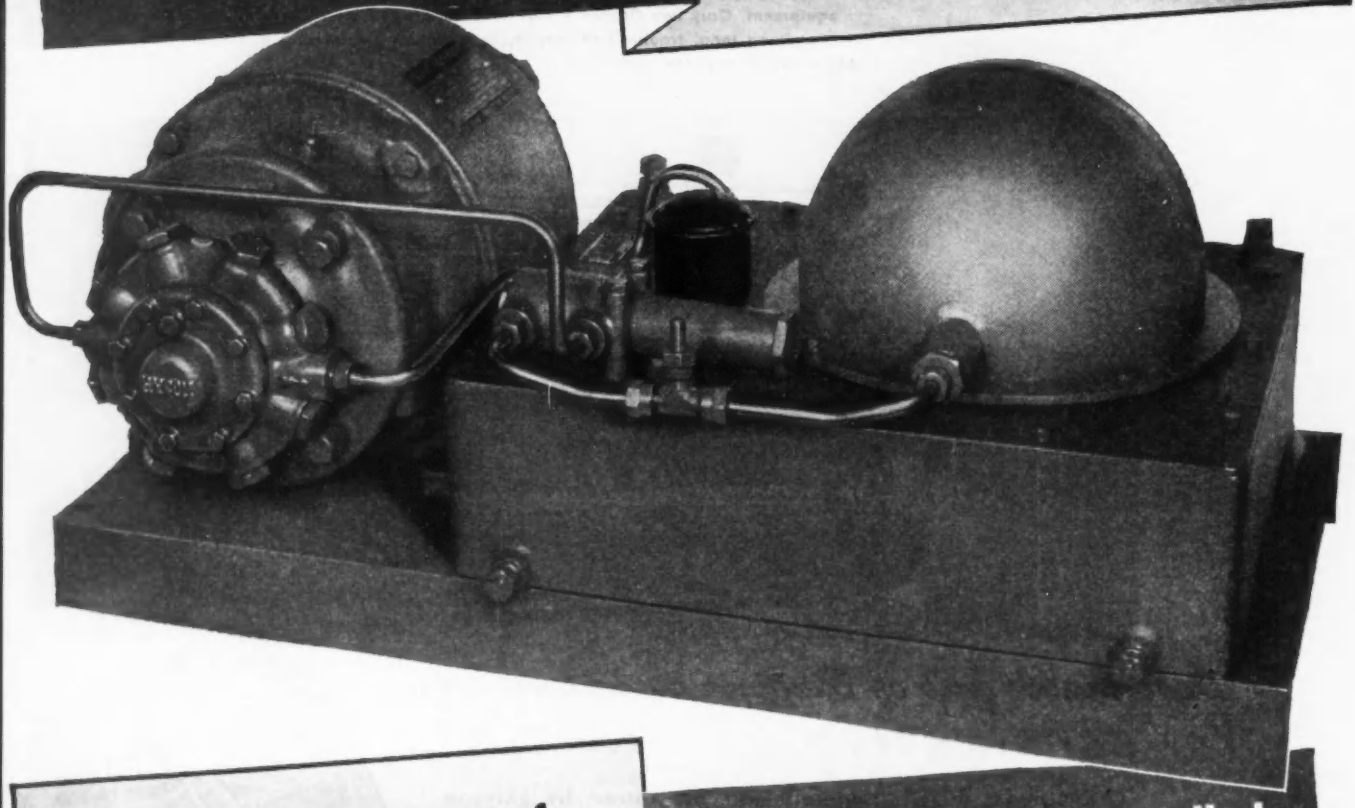
REG. TRADE MARK THE DAYTON RUBBER MFG. CO.

The Mark of Technical Excellence in Synthetic Rubber

HYCON

3000 p.s.i. Hydraulic Power Unit

3 HP Motor
8 cylinder Pump
Unloading Valve
Accumulator and Reservoir



A small compact unit for machine tools, hydraulic presses and test equipment

Quickly and easily installed for smooth reliable hydraulic operations up to 3000 p.s.i.

Specifications and Engineering Data on Request

THE NEW YORK AIR BRAKE COMPANY

Hydraulic Division

420 Lexington Avenue, New York 17, N. Y. Factories: Watertown, N. Y.

TOOLS AND TECHNICIANS
..Yours On Contract

"like adding a wing to your plant"

Planning to add products to your line? Do it *without* manufacturing headaches . . . new equipment expenditures . . . tooling-up delays . . . employee instruction problems . . . sudden big increases in manpower demands!

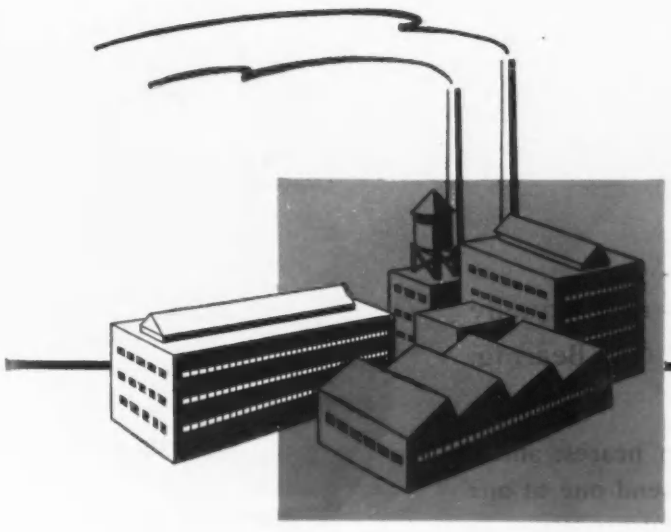
Do it in one of three ways. Let a *qualified organization* (1) make the parts that pose your problems, (2) make the entire new article, or (3) make and market the article.

Qualified should mean ample manufacturing facilities in plant and personnel, in machines and in technicians who supervise their use — and, in the case of Foote, Pierson, it means all that and more!

With Foote, Pierson's wide background goes a service which can include: engineering and design, machine shop, plating and metal finishing, assembly; inspection and checking; packing, warehousing and storage. Foote, Pierson's favorable location, in an area served by a number of main railroads, also offers shipping advantages by water and by air freight.

Foote, Pierson was among the first to produce non-interfering succession fire alarm call boxes, stock tickers, x-ray apparatus, many components of telegraph equipment, instruments and aircraft radio communication apparatus.

There's no obligation in a get-together conversation now for post-war suggestions on your product.



FOOTE · PIERSON & CO · INC

75 Hudson Street Newark 4, N. J.

Established FP *in 1896*

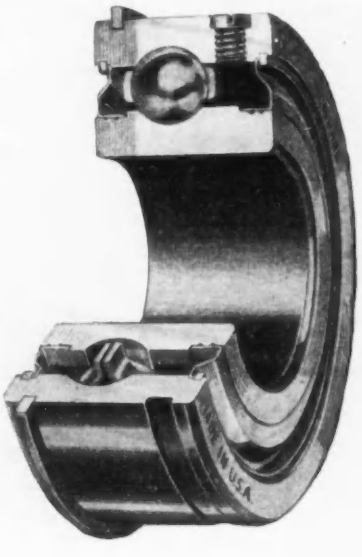
NATURE *proudes*

...EXTRA GREASE CAPACITY FOR PROTECTION

But — among "Self-Protected" and "Sealed" bearings it's the NORMA-HOFFMANN "CARTRIDGE" BALL BEARING that provides that extra—more than double—grease capacity so vital to long life, low maintenance and minimum attention.

• • •

There are many other distinctive — and equally valuable — features, in the "CARTRIDGE" Bearing.



Write for full details to our nearest office. Or,—better yet—ask them to send one of our engineers to discuss your bearing problem—in strict confidence, of course.

NORMA-HOFFMANN BEARINGS CORP'N. STAMFORD, CONN. *Founded* 1911

Field Offices: NEW YORK • CHICAGO • CLEVELAND • CINCINNATI • PITTSBURGH • DETROIT • LOS ANGELES • SAN FRANCISCO • SEATTLE, WASH.

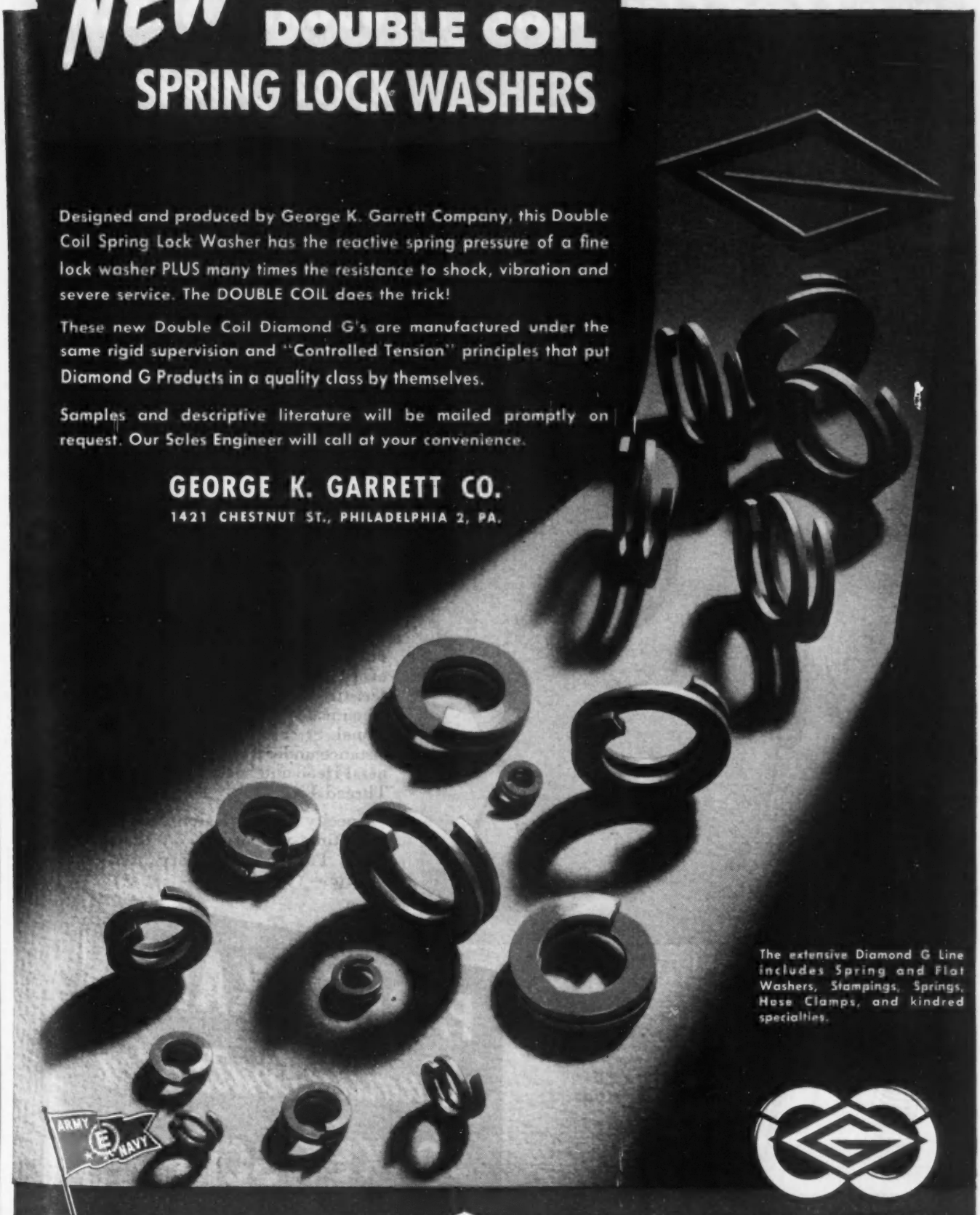
NEW DIAMOND DOUBLE COIL SPRING LOCK WASHERS

Designed and produced by George K. Garrett Company, this Double Coil Spring Lock Washer has the reactive spring pressure of a fine lock washer PLUS many times the resistance to shock, vibration and severe service. The DOUBLE COIL does the trick!

These new Double Coil Diamond G's are manufactured under the same rigid supervision and "Controlled Tension" principles that put Diamond G Products in a quality class by themselves.

Samples and descriptive literature will be mailed promptly on request. Our Sales Engineer will call at your convenience.

GEORGE K. GARRETT CO.
1421 CHESTNUT ST., PHILADELPHIA 2, PA.

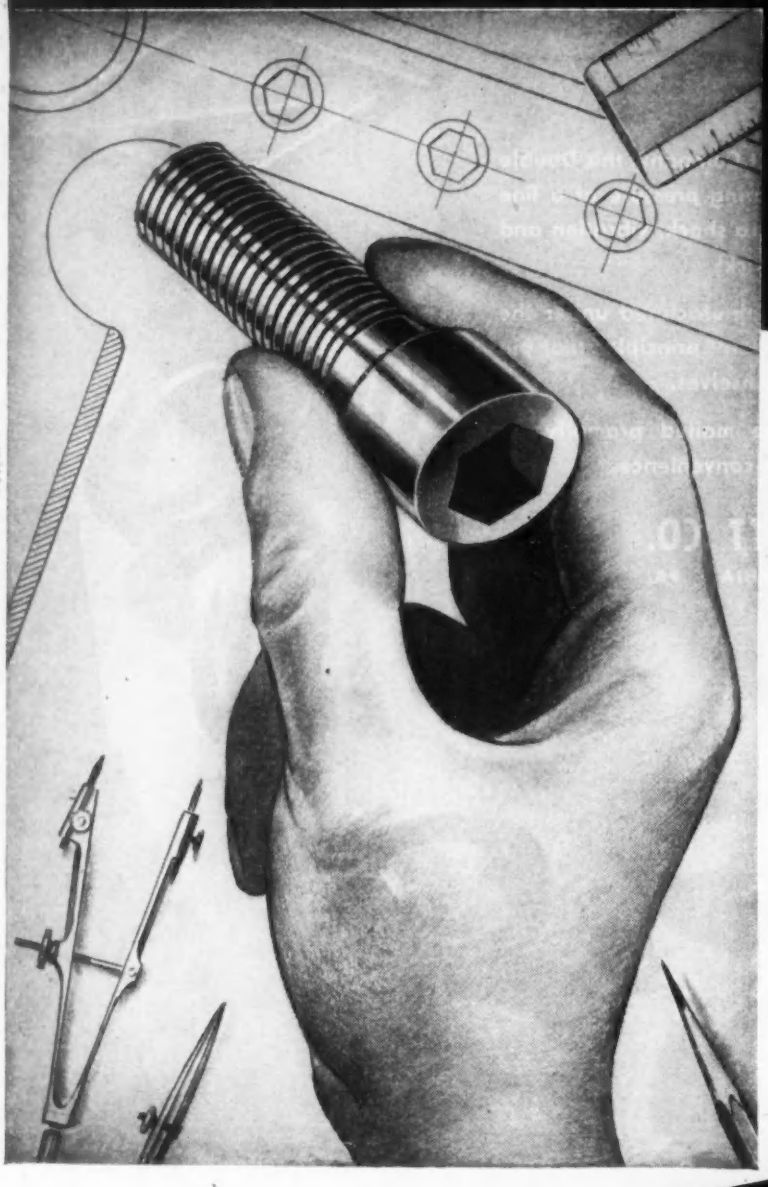


The extensive Diamond G Line includes Spring and Flat Washers, Stampings, Springs, Hose Clamps, and kindred specialties.

DIAMOND PRODUCTS

WHEN *Good Design* CALLS FOR SOCKET SCREWS

Good Judgment CALLS FOR PARKER-KALON *Controlled Quality*

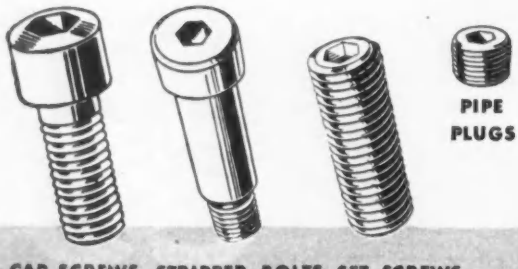


Whenever you specify Socket Screws, it is because you need strength, safety, compactness, or other advantages.

Since you use them when you need an *exceptional* fastening, it is good judgment to make sure you get Socket Screws of *exceptional* quality. At such critical points in your assemblies, you can't afford to have "doubtful" screws . . . screws that *look* all right, but some of which fail to *work* right.

Parker-Kalon's Quality-Control routine, unequalled in the industry, rules out "doubtful" screws by checking every mechanical and physical characteristic. Tests and inspections cover Chemical Analysis; Tensile and Torsional Strength; Ductility; Shock Resistance under Torsion and Shear; Hardness; Head and Socket Size and Position; Thread Fit.

Specify Parker-Kalon Socket Screws next time you order . . . they cost no more. Parker-Kalon Corp., 202 Varick St., New York 14, N. Y.



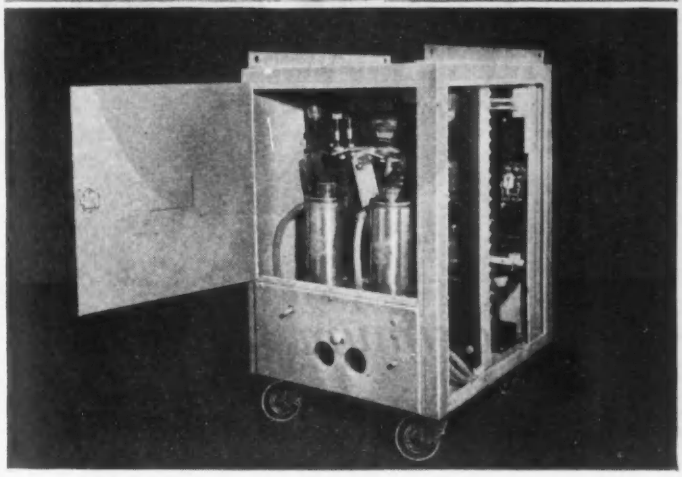
PIPE PLUGS

CAP SCREWS STRIPPER BOLTS SET SCREWS

PARKER-KALON *Quality-Controlled* SOCKET SCREWS

A product of PARKER-KALON ... Specialists in Fastening Devices

ONE GOOD IDEA LEADS TO ANOTHER



Bassick "Floating-Hub" Caster
Sprung-wheel, shock-absorbing caster that is already known as "the caster of the future."

Casters designed for protecting materials in transit also lengthen life of equipment.

More types of equipment have been made portable since the war began — and portable equipment has been improved. If making your product portable, or improving its portability, will make it more saleable—it will help to review recent progress in caster mobility.

The solution to *your* problems of ease of movement, flexibility, floor protection, etc., may be an adaptation of the solution to somebody else's problem.

For example, Bassick's "Floating-Hub" Caster was intended originally for use when moving materials that must not be jarred by uneven floors. It also proved so successful in lengthening the life of the equipment, protecting floors, giving easier handling, that it is now specified where ordinary unsprung wheel casters were once considered good enough.

Other Ideas from Bassick

Other Bassick developments — such as Position Locks, Grooved-Wheel Casters, Super Heavy Duty Precision Casters — are worth investigating. Bassick makes the widest variety of casters and caster equipment in the world, and is the firm that is looked to for the important improvements.

Call in a Bassick engineer to help you develop your idea, while it is still on the board, around standard Casters. THE BASSICK COMPANY, Bridgeport 2, Conn. Div. of Stewart-Warner Corporation, Chicago, Ill. Canadian Division: Stewart-Warner-Alemite Corporation of Canada, Ltd., Belleville, Ont.

THREADED STEMS
Many sizes and types of Bassick Casters are available with threaded stems. From light casters with 1¼" diam. wheels to 8" diam. truck casters.

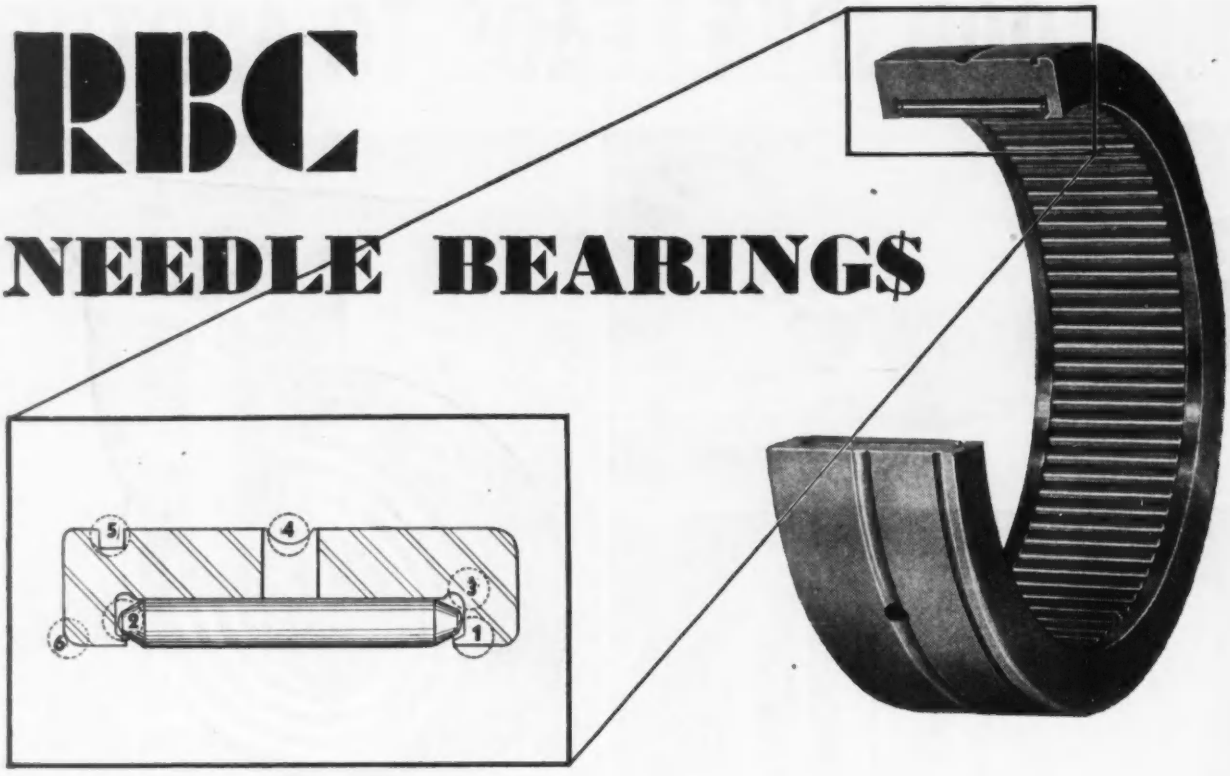
ANGLE STEMS
For direct application to angle iron legs or inside corners. Stems so designed that separate right and left hand types are not needed. 2½" to 8" sizes.

Making more kinds of Casters... Making Casters do more

Bassick

RBC

NEEDLE BEARING$



Close up diagram showing cross-section of one-piece outer race with roller in place.

1. One-piece outer race of channel cross-section; no auxiliary parts necessary as rollers are retained by lips machined directly in race.
2. Rollers have conispherical ends which make ball contact with race shoulders.
3. Recesses adjacent to roller ends act as lubricant reservoir.
4. Oil groove in outer race, making a lubricating groove in the housing unnecessary.
5. A snap ring used in this groove will locate bearing in housing, thus eliminating housing shoulder and reducing costs.
6. Corner radii on inside edges of the outer race facilitate assembly of the bearing on the shaft.

RBC
MORE THAN
25
YEARS
EXPERIENCE

—for Maximum Capacity and Minimum Dimensions

The demand for lighter, longer-lived products has been gathering momentum for the last decade. This is as true of vacuum cleaners as it is of Pullman cars.

The development of the Needle Bearing over ten years ago by R B C has been an important contribution to this trend. Its widespread application has made possible economies in weight and increased length of life undreamed of at the start.

If you have a weight or an endurance problem, please consult R B C's Engineering Staff.

ROLLER BEARING CO. OF AMERICA
TRENTON, NEW JERSEY

Economical Oilgear Radial Rolling Piston power units are used to charge stationary and portable catapult power plants to catapult planes at flying speeds in something over 100 feet. Besides high linear speed obtainable over a wide range, acceleration and/or deceleration are controlled, power can be stored during idle period.

FROM ZERO TO FLYING SPEED IN A MATTER OF SECONDS

ARE YOU TRYING TO:

1. Apply large forces through long . . . or short . . . strokes at variable speeds?
2. Obtain automatic work cycles, variable speeds in either direction . . . with or without preset time dwell?
3. Apply large forces through continuous or intermittent reciprocating cycles at constant or variable velocities?
4. Obtain extremely accurate control of either position or speed or a reciprocating member?
5. Apply accurately variable pressure either static or in motion?
6. Closely synchronize various motions, operations or functions?
7. Apply light . . . or heavy . . . forces at extremely high velocities through either long or short distances of travel?
8. Obtain continuous automatic reversing drives at constant R.P.M. or over a wide range of speed variation?
9. Obtain accurate remote control of speed and direction of rotation, rates of acceleration, and/or deceleration?
10. Obtain constant horsepower output through all or part of a speed range?
11. Obtain automatic torque control?
12. Obtain accurately matched speed of various rotating elements?
13. Obtain constant speed output from a variable speed input?
14. Obtain full preset automatic control, elimination of problems of shock, vibration, etc.?

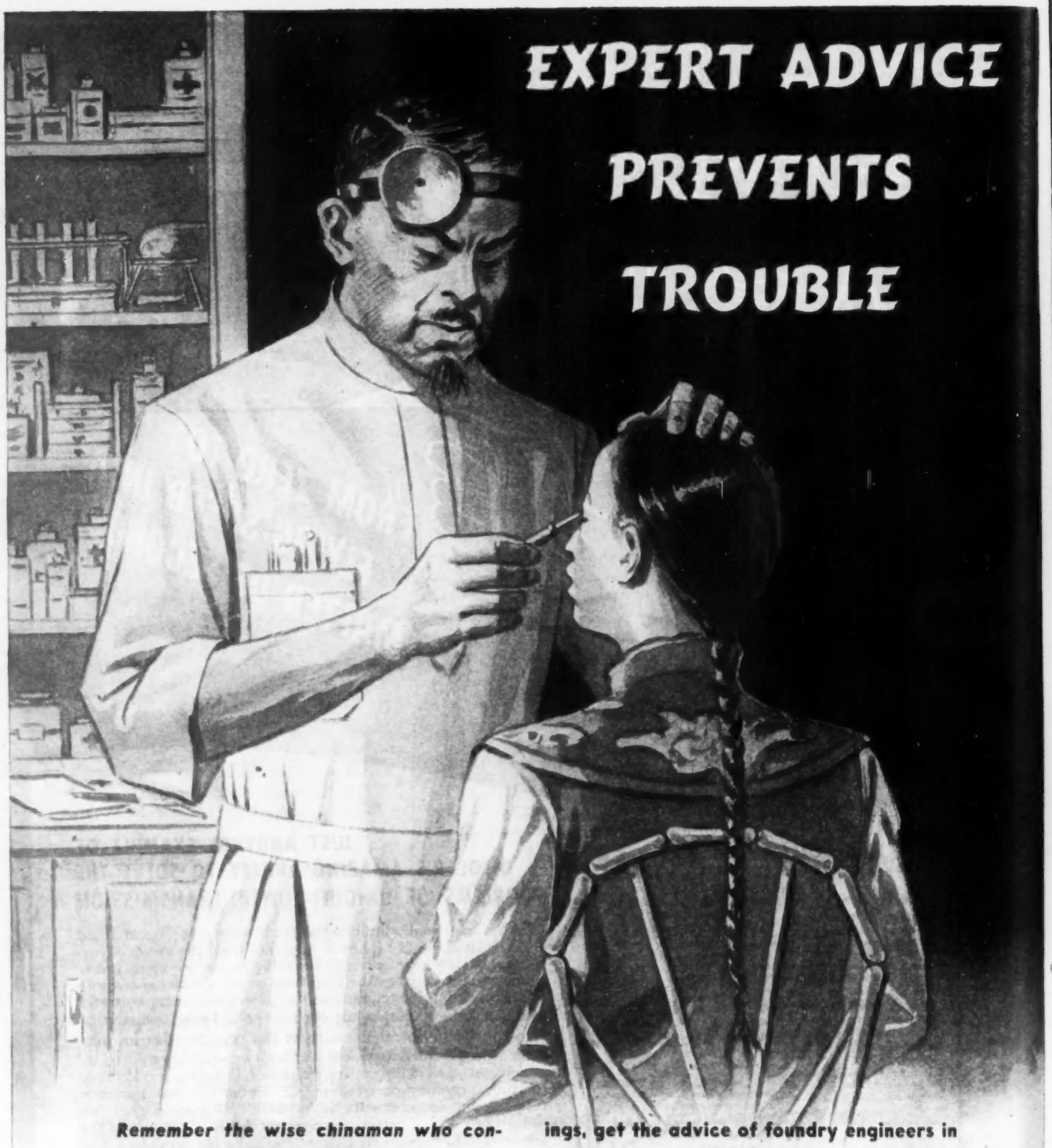
You Need Oilgear!

JUST ANOTHER EXAMPLE OF OILGEAR'S AMAZING ABILITY TO SOLVE THE PROBLEMS OF UNIQUE POWER TRANSMISSION

There is hardly any limit to the applicability of Oilgear Fluid Power. In catapulting heavy airplanes from the decks of carrier escorts, Oilgear not only furnishes the tremendous power required to accelerate the load from zero to flying speed in a few seconds but it accumulates this power with comparatively small, standard units while each plane is being maneuvered into position. ***You*** can use units of this type on other installations where tremendous power or high velocity is required intermittently, as in die casting machines, braiding and knitting machines, riveting presses, etc. Or if your machine power or transmission requirements lie far afield, they are almost certain to be met . . . better, more economically . . . in any of the scores of other functions Oilgear Fluid Power provides. Just as war industry built upon peacetime knowledge, so today shrewd designers are adopting the lessons learned in war. Put ***your*** problem up to Oilgear engineers; see if their solution isn't what you've been looking for. Do it *now* . . . . . THE OILGEAR COMPANY, 1311 W. Bruce St., Milwaukee 4, Wis.

OILGEAR

Fluid Power



EXPERT ADVICE PREVENTS TROUBLE

Remember the wise chinaman who consults his physician before taking sick?

If your plans call for the light weight, strength and durability of magnesium castings, get the advice of foundry engineers in the design stage . . . . prevent production troubles later. *Superior* engineers will be glad to work with you. No obligation.

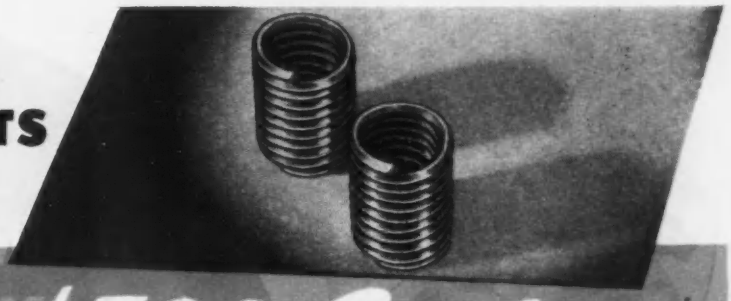
Informative Booklet "Facts for the Designer" Available Upon Request

Superior Bearing Bronze Co., Inc.

MAGNESIUM DIVISION • 147 BANKER ST. • BROOKLYN 22, N. Y.

MAGNESIUM CASTINGS TO MEET U. S. ARMY & NAVY SPECIFICATIONS

HOW *Heli-Coil* INSERTS



Salvage a $500 Casting

IN THREE SIMPLE STEPS!

"Heli-Coil" Inserts restore to correct size, holes that have been accidentally tapped too large. And they do it simply, accurately, economically. They eliminate the need for oversize screws or studs—time-consuming fitting of solid bushings—or the complete scrapping of the casting!

At the Syracuse, N. Y., plant of Aircooled Motors Corporation, for example, "Heli-Coil" Inserts are used to salvage aluminum alloy helicopter crankcase castings valued at $500—as well as in intermediate and timing gear case magnesium castings. Formerly, even when a casting had only one hole tapped oversize, it was necessary to scrap it because of the rigid production standards required. Today, "Heli-Coil" Inserts eliminate this waste!

"Heli-Coil" Inserts are precision-shaped helical coils of stainless steel or phosphor bronze wire, which engage screw threads of the American National System. In addition to their many applications in salvage, maintenance and field servicing, "Heli-Coil" Inserts are widely used in original installations in aluminum and other light metal parts. These inserts provide a hard, anti-friction, protective lining for tapped threads in these softer metals . . . preventing thread stripping, seizing and galling. Write today for complete engineering information.

U. S. and foreign patents issued and pending.

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LOS ANGELES
J. S. Wise
Room 925, Pacific Mutual Bldg.
523 West 6th St.
Los Angeles, California

HELI COIL

THE SCREW SYSTEM WITH THE ANTI-FRICTION THREAD LINING

AIRCRAFT SCREW PRODUCTS COMPANY, INC.
47-23 35th STREET • LONG ISLAND CITY, 1, N.Y.

PLAY SAFE BY PLANNING FASTENINGS EARLY IN PRODUCT DESIGN STAGE

"Cold-forging"—proof #28 ... more each month

3 Standard Fastenings for Production Efficiency

1 **Phillips Recessed Head Screws**—The modern, effective, time-saving fastening device proven in tens of thousands of assembly lines. Other standard head styles are also available.

2 **Self-Tapping Machine Screws**—Eliminate separate tapping operations for fastenings to castings, heavy gauge sheet metal, and plastics. Also available with Phillips Recessed Head.

3 **Washer-Screw Assemblies**—When use of lock washers is indicated, the time-saving of pre-assemblies is obvious. Also available in standard slotted head styles.

It's our business to help you play safe by assisting you in the design or selection of the proper "all important" fastenings for your product. By making that decision early, while your product is still in the design stage, you can prepare ahead for the fast and precise assembly job essential to your product's success.

Our broad experience in fastenings and our demonstrated ability in special design makes Scovill your logical choice. We will recommend the best modern fastening for your specific need—a featured standard fastening, or a part requiring our ingenuity in special design and cold-forging such as illustrated by the special purpose item shown above. Our special processing of this part, too, meant substantial savings in money—materials—motions.

Call our Fastenings Expert to serve you . . . and profit by our demonstrated Scovill ability in standard or special design and cold-forging. Call *Today*.

SCOVILL MANUFACTURING COMPANY

WATERVILLE SCREW PRODUCTS DIVISION

WATERVILLE 48, CONN. TEL. WATERBURY 3-3151

NEW YORK, Chrysler Building · DETROIT, 714 Fisher Building · CHICAGO, 135 South LaSalle Street · PHILADELPHIA, 18 W. Chelten Avenue Building
PITTSBURGH, 2882 W. Liberty Ave. · SYRACUSE, Syracuse-Kemper Insurance Bldg. · LOS ANGELES, 2627 S. Soto St. · SAN FRANCISCO, 434 Brannan St.

AUTO-LITE
Electrical
Wire AND Cable

WHEN manufacturers of electrical equipment turn to Auto-Lite to furnish the wire and cable they need, they know they'll get a precision-made product, famed for its dependability. They know that the name Auto-Lite stands for aggressive research, precise engineering and a high quality product. They know of many of Auto-Lite's special insulations, such as Auto-Lite's Vega Chromoxide Enamel, an insulation of particular advantage where heat-resistance is of paramount importance. All these things make it natural for them to turn to Auto-Lite when wire and cable problems arise. Address your inquiries to

THE ELECTRIC AUTO-LITE COMPANY

SARNIA, ONTARIO — *Wire and Cable Division* — PORT HURON, MICH.

Tune in
AUTO-LITE'S
GREAT NEW SHOW
STARRING
DICK HAYMES
IN
"EVERYTHING FOR THE BOYS"
Featuring Men and Women at the fighting fronts
Tuesday Nights—NBC Network

IN ITS 22 GREAT MANUFACTURING PLANTS, AUTO-LITE IS PRODUCING A LONG LIST OF ITEMS FOR AMERICA'S ARMED FORCES ON LAND, SEA AND IN THE AIR

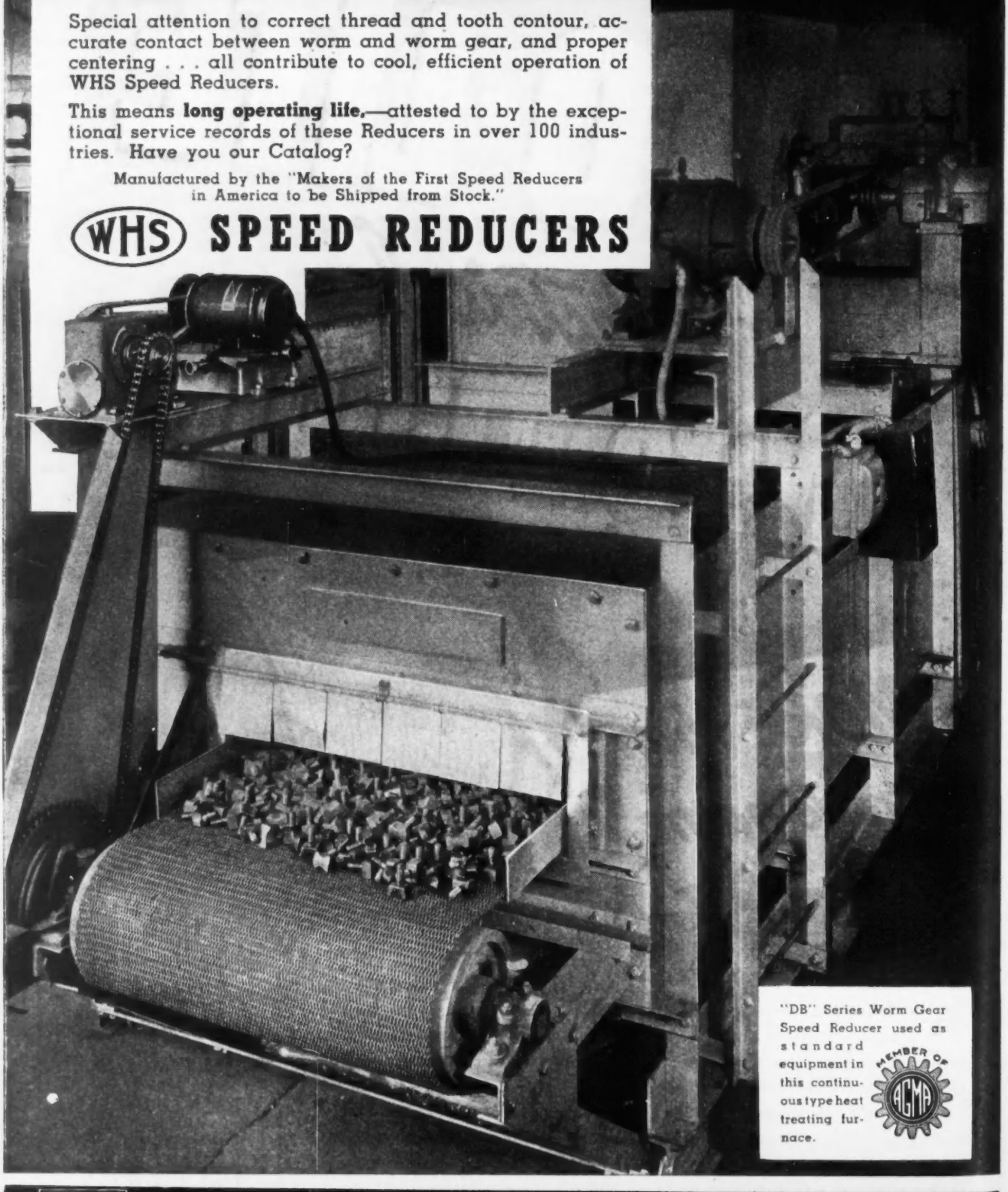
ABSOLUTELY DEPENDABLE
...under The Most Rigorous Conditions

Special attention to correct thread and tooth contour, accurate contact between worm and worm gear, and proper centering . . . all contribute to cool, efficient operation of WHS Speed Reducers.

This means **long operating life,**—attested to by the exceptional service records of these Reducers in over 100 industries. Have you our Catalog?

Manufactured by the "Makers of the First Speed Reducers in America to be Shipped from Stock."

WHS **SPEED REDUCERS**



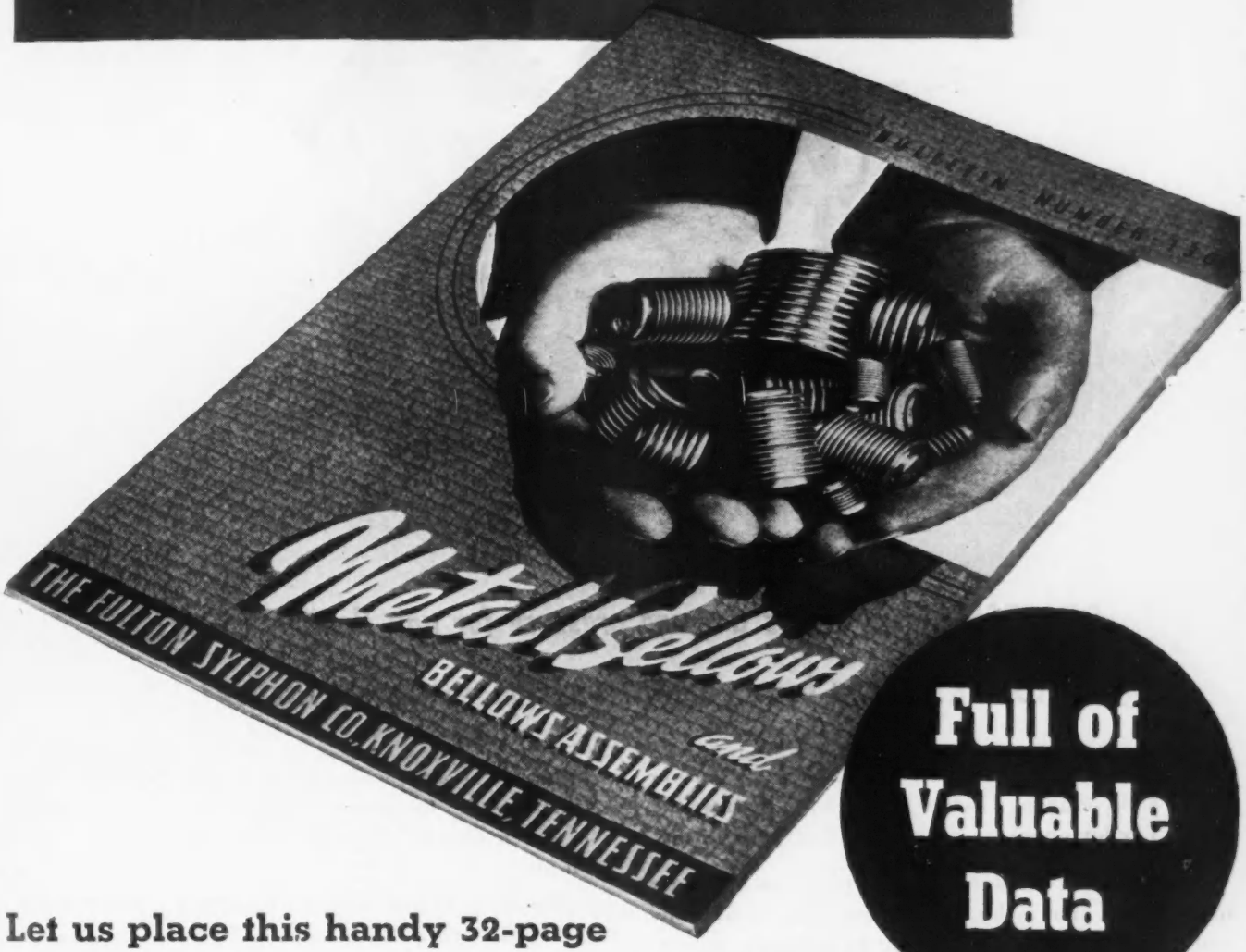
"DB" Series Worm Gear Speed Reducer used as standard equipment in this continuous type heat treating furnace.

MEMBER OF AGMA

WINFIELD H. SMITH, Inc.

111 EATON STREET,...SPRINGVILLE...ERIE COUNTY...NEW YORK

Just say the word*...



Full of Valuable Data

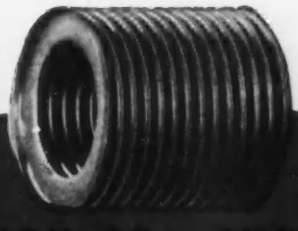
Let us place this handy 32-page reference book on your desk without charge

ALL ABOUT BELLOWS, bellows assemblies, and bellows devices. How they are made, what they do, life expectancies, etc. Complete information on physical characteristics, sizes, metals, assemblies, applications, etc., etc. Included are many useful time-saving tables—equivalents, conversion equations, temperature conversions, and physical data on approved charges; also pages of drawings detailing design and construction, together with photographs of special bellows and interesting assemblies.

*Write on your letterhead: "YES, I'd like to receive a copy of the new Fulton Sylphon Bulletin CP-1300."

NEW MOVIE—"The Story of Metal Bellows" is available to interested executives and organizations.

FULTON SYLPHON



TEMPERATURE CONTROLS — BELLOWS — BELLOWS ASSEMBLIES

THE FULTON SYLPHON CO., KNOXVILLE 4, TENNESSEE

DRAFTSMAN: *"That's a tough pressure for any flexible tubing!"*

DESIGNER: *"You bet... That's why I'm specifying Titeflex!"*

You'll find machine designers among the most enthusiastic and confident Titeflex boosters . . . because for them, Titeflex opens up a new world of possibilities.

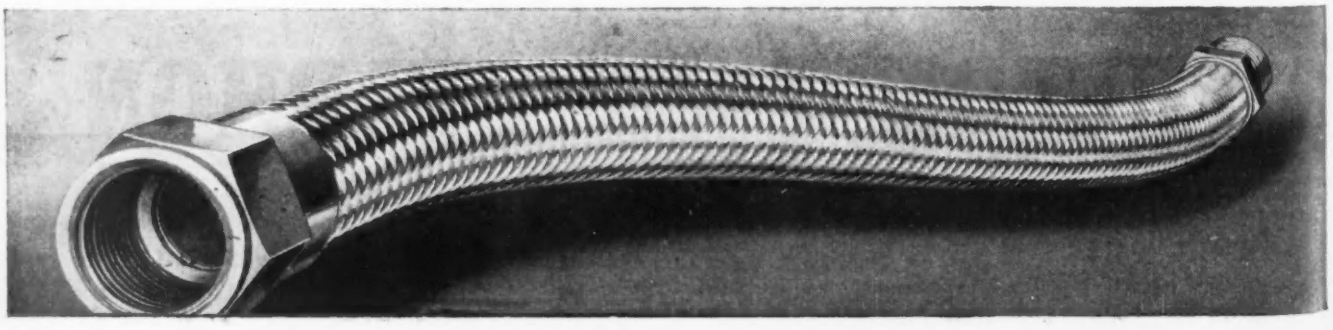
With Titeflex the designer can design as he *wants* to design . . . not as he *must* through the limitations and restrictions imposed on him by ordinary tubing. He knows, for instance, that Titeflex will handle vibration and provide great flexibility. It will withstand high temperatures and permit the safe handling of most corrosives. Titeflex will stand pressures that would cause failure in most types of tubing. In a word . . . the designer knows that in Titeflex he finds the *combined* qualities of all good flexible tubing.

Titeflex is an *all-metal* flexible tubing. It contains no packing or composition material. There is nothing in Titeflex tubing to wear out or deteriorate in use. Points of greatest wear in Titeflex are protected by 4 thicknesses of metal and the protective outer braiding is woven directly onto the tubing itself—not slipped on afterwards.

Titeflex is "Headquarters" for metal flexible tubing. Our engineering staff is ready at all times to cooperate on tubing problems. The new 36 page Titeflex catalog contains detailed information on Titeflex and Titeflex fittings. A letter will bring it to you.

TITEFLEX, INC., 518 Frelinghuysen Ave., Newark 5, N.J.

Titeflex



ASSEMBLY - ENGINE MOUNT - REAR SUPPORT
TO CENTER OF ROTATION
ENGINE BLOCK
ENGINE MOUNT - REAR SUPPORT
THE GENERAL TIRE & RUBBER CO.
B 1759

How General Silentbloc Rubber Parts Can Improve a Product and Cut Costs

WHEN a simple rubber-and-metal part can improve your product and may also cut manufacturing costs—*that's news.*

Here are three ways General Silentbloc parts offer this double advantage:

1. *By giving engineered control of vibration and shock load,* Silentbloc Mountings step up operating efficiency, save maintenance and lengthen life. Better vibration control may enable you to take out weight and simplify assembly.

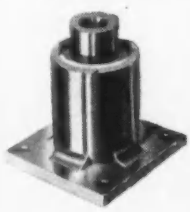
2. *By correcting for misalignment* in shaft supports, bearings and hinges, Silentbloc Bushings cut damage and wear, improve operation. You may eliminate machining and fitting to close tolerances.

3. *In oscillating joints,* Silentbloc Bearings give controlled torque action—trouble-free, long-lasting and needing no lubrication. They may replace expensive bearings and speed up production.

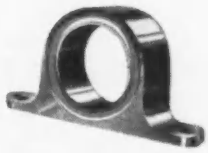
Rubber Before Assembly — After Assembly

This diagram shows the patented Silentbloc method of elongating and confining rubber between the outer and inner metal sleeves, forming an indestructible union of rubber-to-metal. By varying the elongation and modulus of the rubber, the size and shape of metal parts, General engineers can design a Silentbloc to give the exact performance you need. Silentbloc can be made of any metal and any type of rubber, to carry loads of ounces to tons.

The Silentbloc has proved its value in automotive, industrial and household equipment, aircraft, motors of all kinds, marine and electrical equipment. To learn how Silentbloc parts may improve your product, write for free booklet. The General Tire & Rubber Company, Dept. 160, Wabash, Indiana.



Platform-type Silentbloc floor mounting for motors and heavy equipment. Well-type motor-mounting shown at top can be made in any size and design.



One type of Silentbloc shaft mounting to correct for misalignment. Silentbloc bushings for bearings and hinges can be designed to fit your needs.

Typical Silentbloc rubber bearing for torque joint. Inner shaft can be plain, threaded or grooved. No lubrication; long lasting; trouble-free.

The GENERAL SILENTBLOC
MOUNTINGS . . . BEARINGS
COUPLINGS

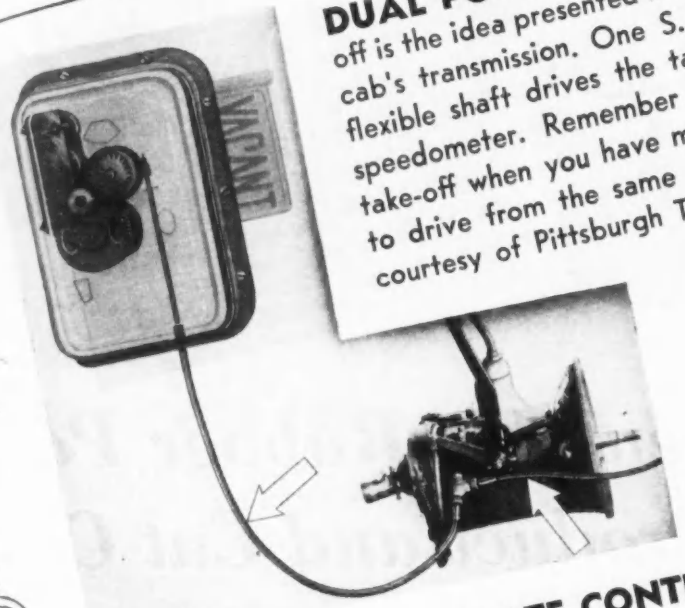
THE GENERAL TIRE & RUBBER COMPANY

Mechanical Goods Division, Wabash, Indiana

Ideas FOR DESIGN-ENGINEERS—IN THESE USES OF *S.S.White Flexible Shafts*

ONE OF A SERIES showing typical POWER DRIVE and REMOTE CONTROL applications

DUAL POWER DRIVES from a single take-off is the idea presented in this illustration of a taxi-cab's transmission. One S. S. White power drive flexible shaft drives the taximeter, the other, the speedometer. Remember this dual flexible shaft take-off when you have more than one mechanism to drive from the same power source. Illustration courtesy of Pittsburgh Taximeter Co.



CONVENIENT REMOTE CONTROL of valves, switches and other mechanisms located in inaccessible places, can be readily obtained with S. S. White remote control flexible shafts. For example, the hook-up shown was used in a motor vehicle to facilitate opening and closing the drain valve on the bottom of the crank case, with the operating end in easy reach under the hood.

FLEXIBLE SHAFT HANDBOOK FREE TO ENGINEERS

This newly published 256-page handbook gives complete information and engineering data on both power drive and remote control flexible shafts and how to apply them. A copy, free to any engineer who complies with this provision — make your request on your business letterhead and indicate your position.

ARMY E NAVY

S.S.WHITE INDUSTRIAL DIVISION

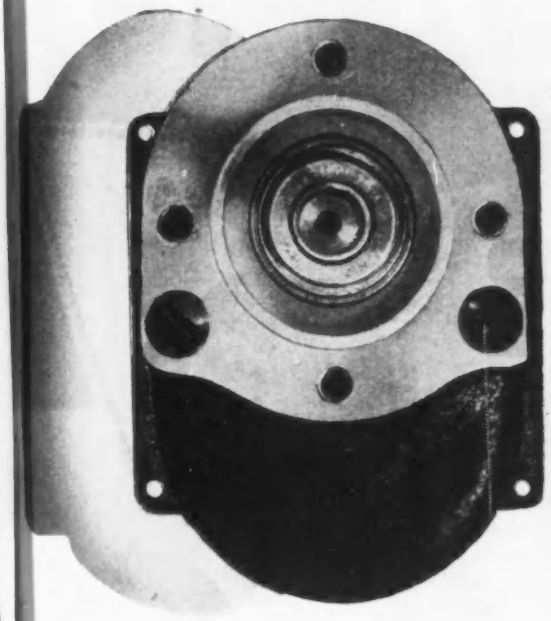
THE S. S. WHITE DENTAL MFG. CO.

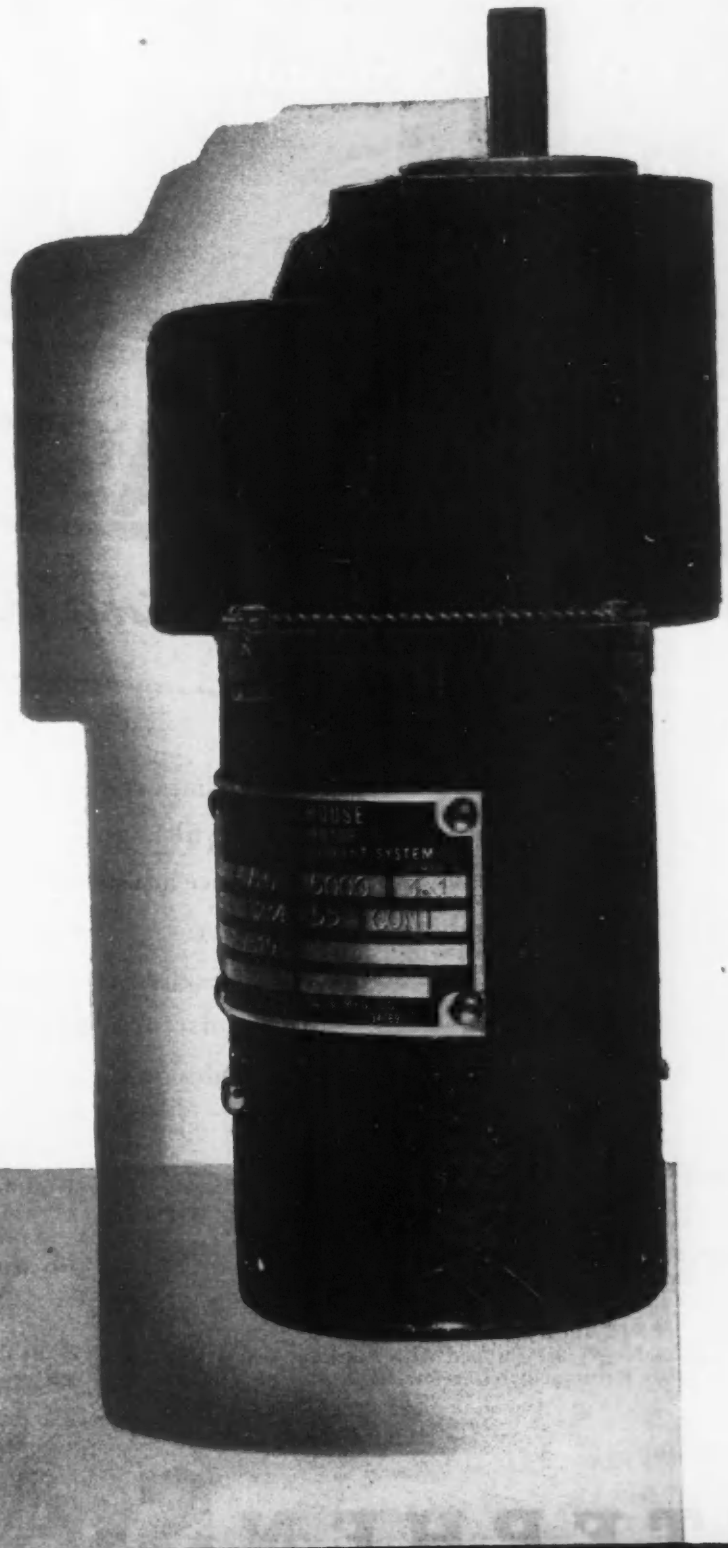
DEPT. D 10 EAST 40th ST., NEW YORK 16, N. Y.

FLEXIBLE SHAFTS — AIRCRAFT ACCESSORIES
MOLDED PLASTICS
MOLDED RESISTORS — FLEXIBLE SHAFT TOOLS

One of America's AAAA Industrial Enterprises

WE PRODUCE A NEW SMALL ACTUATOR





THIS IS THE ACTUAL SIZE

Recognizing the need for a small, reliable, torque shaft actuator, we have designed and are building this midget of power, as shown here in actual size. It weighs 2 lbs. 6 oz. This little unit can operate an aerial camera, camera doors or other small doors, trim tabs, remote fuel or hydraulic valves. It can be supplied with brake and clutch by adding slightly to length and weight of the model illustrated.

One distinct advantage in this actuator is the fact that the electric motor can be removed without otherwise disengaging the unit from its connection. Mounting flanges are made to fit the specified use.

This unit has been designed and is tested for low-temperature operation. A definite service life and load limit has been calculated in its construction.

SPECIFICATIONS

Overall length — with motor	7-in.
Overall width — " "	2-9/16-in.
Overall height — " "	3-in.
Weight — " "	2 lbs. 6 oz.
Output Shaft Speeds (available as specified)	12½ rpm. 15 rpm. 20 rpm. 25 rpm.
Capacity—Heat-treated spur gears. Capable of handling motors of 1/50 to 1/15 h.p.	
Motor —(Westinghouse). Can furnish fan-cooled, totally enclosed or open type as shown.	24 Volt D.C.

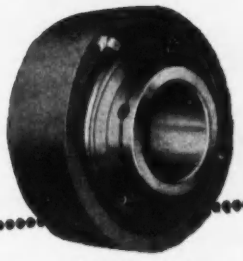
VARD INC.

PASADENA 8, CALIF.

Advanced Design Through an Exclusive Combination of Features

SEALMASTER

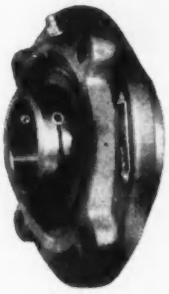
Ball Bearing Units



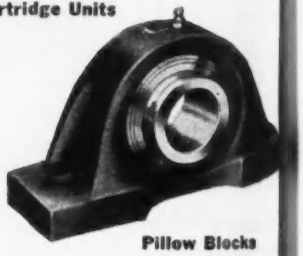
Cartridge Units

• Many of the most important bearing features . . . features which assure long life and top performance are successfully combined in SealMasters.

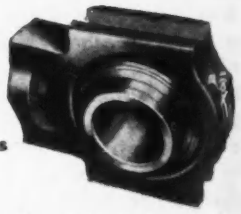
Take advantage of SealMasters exclusive design and construction when designing new, or re-designing existing products.



Flange Cartridge Units



Pillow Blocks



Take-up Units

QUIET IN OPERATION
SealMaster design and construction combine to produce a bearing unusually quiet in operation.

SELF-ALIGNING
Shaft mis-alignment in any direction cannot distort the seal.

PRE-LUBRICATED
SealMasters are shipped with lubricant sealed in . . . ready for immediate service.

PERMANENTLY SEALED
SealMasters have a patented sealing principle, which *seals out* dirt, and *seals in* lubricant.

NO OUTER RACE ROTATION
A patented locking pin keeps outer race from rotating in housing and allows re-lubrication of bearing.

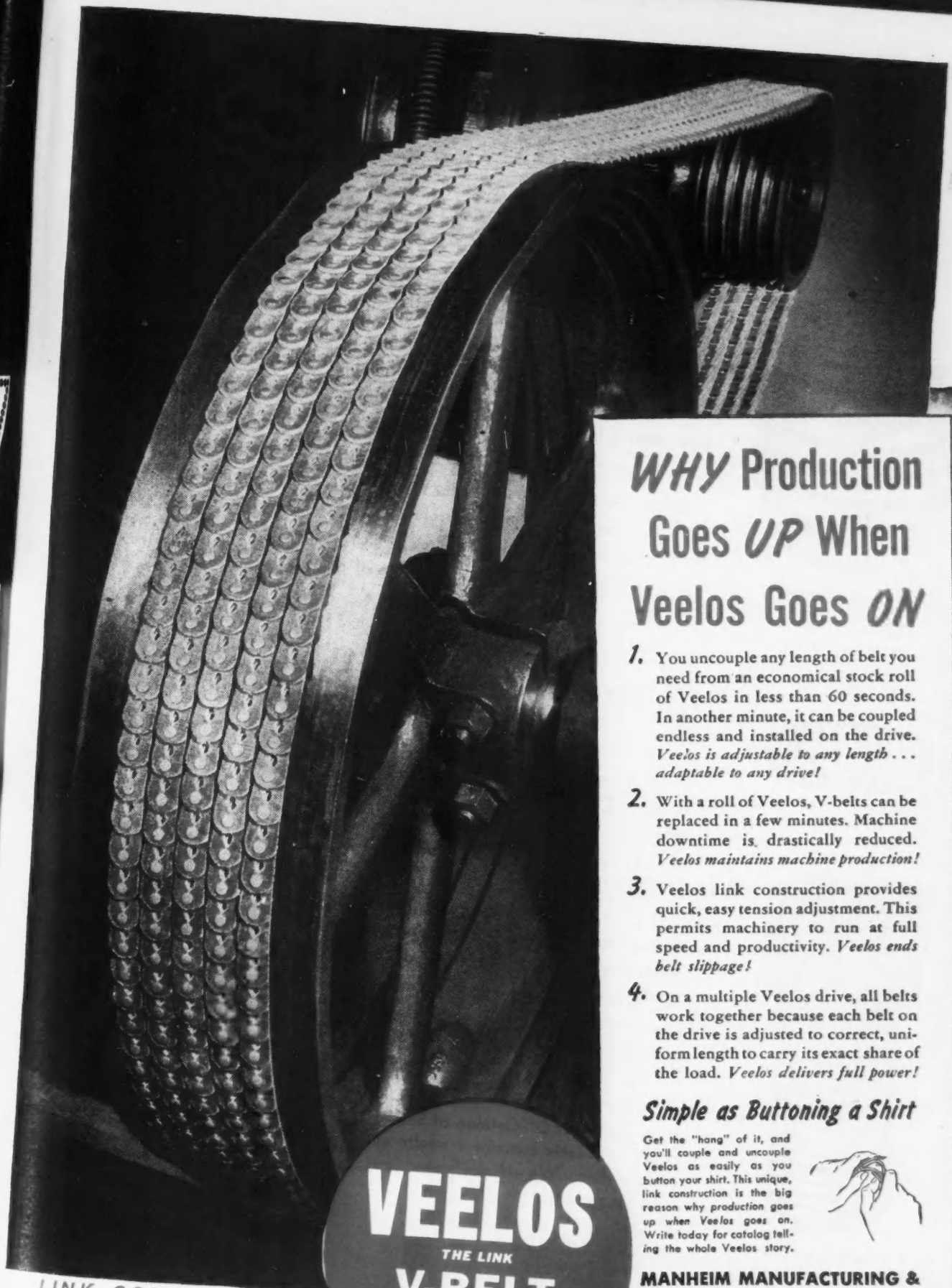
Write for Catalog No. 840, which gives dimensions, load ratings and engineering data on the complete SealMaster line.

BEARING DIVISION

STEPHEN S-A ADAMSON MFG. CO.

9 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities



LINK CONSTRUCTION
UPS PRODUCTION

WHY Production Goes *UP* When Veelos Goes *ON*

1. You uncouple any length of belt you need from an economical stock roll of Veelos in less than 60 seconds. In another minute, it can be coupled endless and installed on the drive. *Veelos is adjustable to any length . . . adaptable to any drive!*
2. With a roll of Veelos, V-belts can be replaced in a few minutes. Machine downtime is drastically reduced. *Veelos maintains machine production!*
3. Veelos link construction provides quick, easy tension adjustment. This permits machinery to run at full speed and productivity. *Veelos ends belt slippage!*
4. On a multiple Veelos drive, all belts work together because each belt on the drive is adjusted to correct, uniform length to carry its exact share of the load. *Veelos delivers full power!*

Simple as Buttoning a Shirt

Get the "hang" of it, and you'll couple and uncouple Veelos as easily as you button your shirt. This unique, link construction is the big reason why production goes up when Veelos goes on. Write today for catalog telling the whole Veelos story.

MANHEIM MANUFACTURING & BELTING CO. MANHEIM, PA.

VEELOS
THE LINK
V-BELT

Adjustable to any Length
Adaptable to any Drive

A machine is only as *Strong* as its weakest part

Pat. & Pat. Pending.

"Unbrako" Hollow Set Screw with the Knurled Point.

No wonder so many designers of machinery specify the "UNBRAKO" Self-Locking Hollow Set Screw. They know they can depend on it to stay in place . . . they know it positively will not work loose even under the most severe vibration. The knurls of its Cup Point dig in and hold tight, making it truly a Self-Locker.

And for use where the Knurled Cup Point Set Screw is unsuitable, specify the "UNBRAKO" Knurled Thread Set Screw, which is also a Self-Locker regardless of the style of point.

UNBRAKO

Reg. U. S. Pat. Off.

KNURLED SOCKET-HEAD CAP SCREWS

Another "UNBRAKO" Screw Product, and one which greatly facilitates assembly work. The knurling of the Socket Head affords a slip-proof grip for mechanics' oily fingers, enabling them to turn it farther and faster before a wrench is needed.

The KNURLING of Socket Screws originated with "Unbrako" years ago.

Furthermore this screw requires less clearance for tightening than old-style hex-heads, because an internal socket screw wrench can be used, thus saving valuable space and material . . . permitting of lighter and less costly designs.

"Unbrako" Socket Head Cap Screw with Knurled Head.

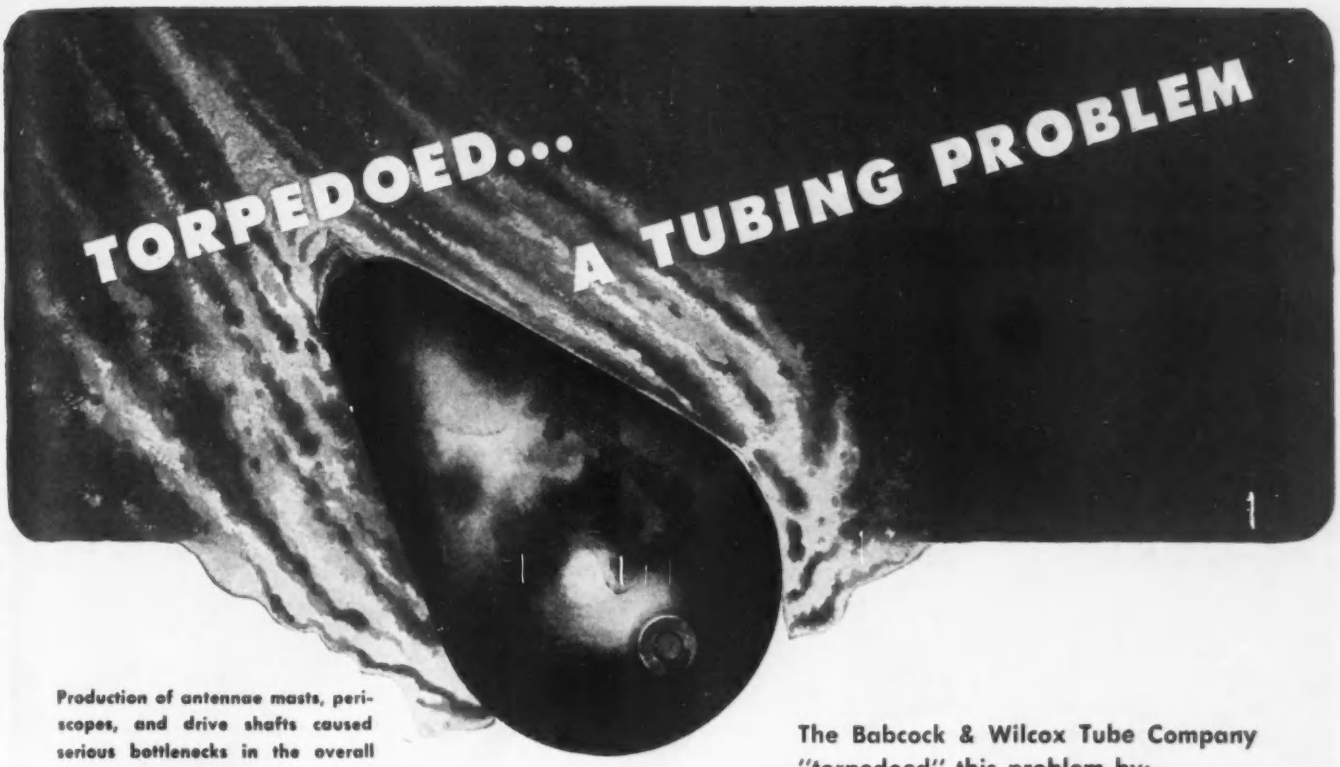
The "UNBRAKO" Catalog of Socket Screw Products contains a wealth of information. We will gladly send you one on request.

OVER 40 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA., BOX 545 · BRANCHES: BOSTON · DETROIT · INDIANAPOLIS · CHICAGO · ST. LOUIS · SAN FRANCISCO

TORPEDOED... A TUBING PROBLEM



Production of antennae masts, periscopes, and drive shafts caused serious bottlenecks in the overall output of submarines. On one of these items — antennae masts — a 40', corrosion-resistant, stainless alloy steel tube weighing 1450 lbs. was needed. *Up until two years ago 1000 lbs. was tops for commercial production of stainless steel tubing.*

THE PROBLEM

to manufacture commercially — a stainless-alloy-steel tubing

- 40' in length
- 6" in diameter
- .600" wall
- 1450 lbs. in weight

SPECIAL REQUIREMENTS

withstand same hydrostatic pressure as body of submarine —

must be non-magnetic —

corrosion resistant to high degree —

absolutely straight — must be projected up and down through a stuffing box —

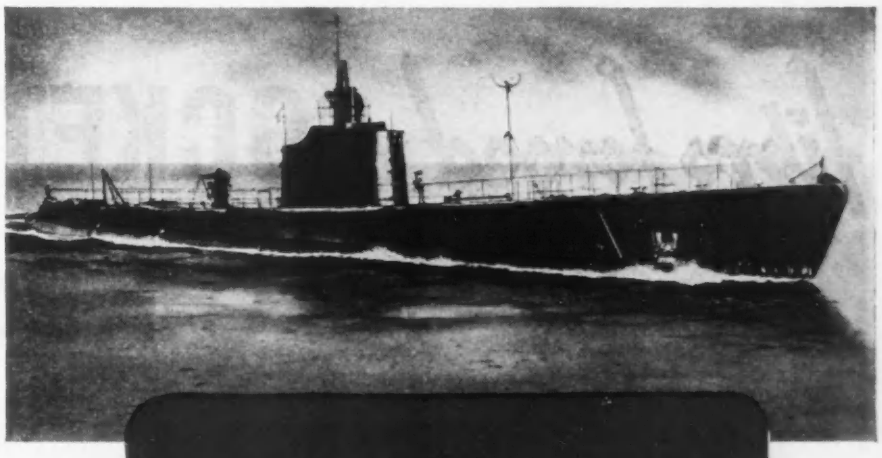
exceptionally close tolerance, as antenna mast must be machined to within .022".

IF YOU THINK WE CAN HELP YOU, WHY NOT WIRE, PHONE OR WRITE NOW?

The Babcock & Wilcox Tube Company "torpedoed" this problem by:

- developing a new simple, ingenious mill operation by experimentation.
- producing the largest individual pieces of stainless steel tubing ever made in this country *in production quantities.*
- speeding production by the B&W method—15% faster than the time required by forging methods.
- meeting the extremely rigorous requirements that are shown on this page.
- following through by using a special method of packaging which insured safe delivery.

Thus, from the presentation of this problem all the way to delivery, it was a typical B&W Tube job . . . not an extraordinary accomplishment. Rather, we would like to have you feel that if you have a tubing problem the same B&W facilities and skill which proved successful in this instance are at your disposal.



B & W TUBES

SEAMLESS. Complete range of carbon, alloy and stainless steels
Sizes: ½ in. to 8⅝ in. O.D.
ELECTRIC-RESISTANCE WELDED. Carbon steel grades
Sizes: ⅜ in. to 4 in. O.D.

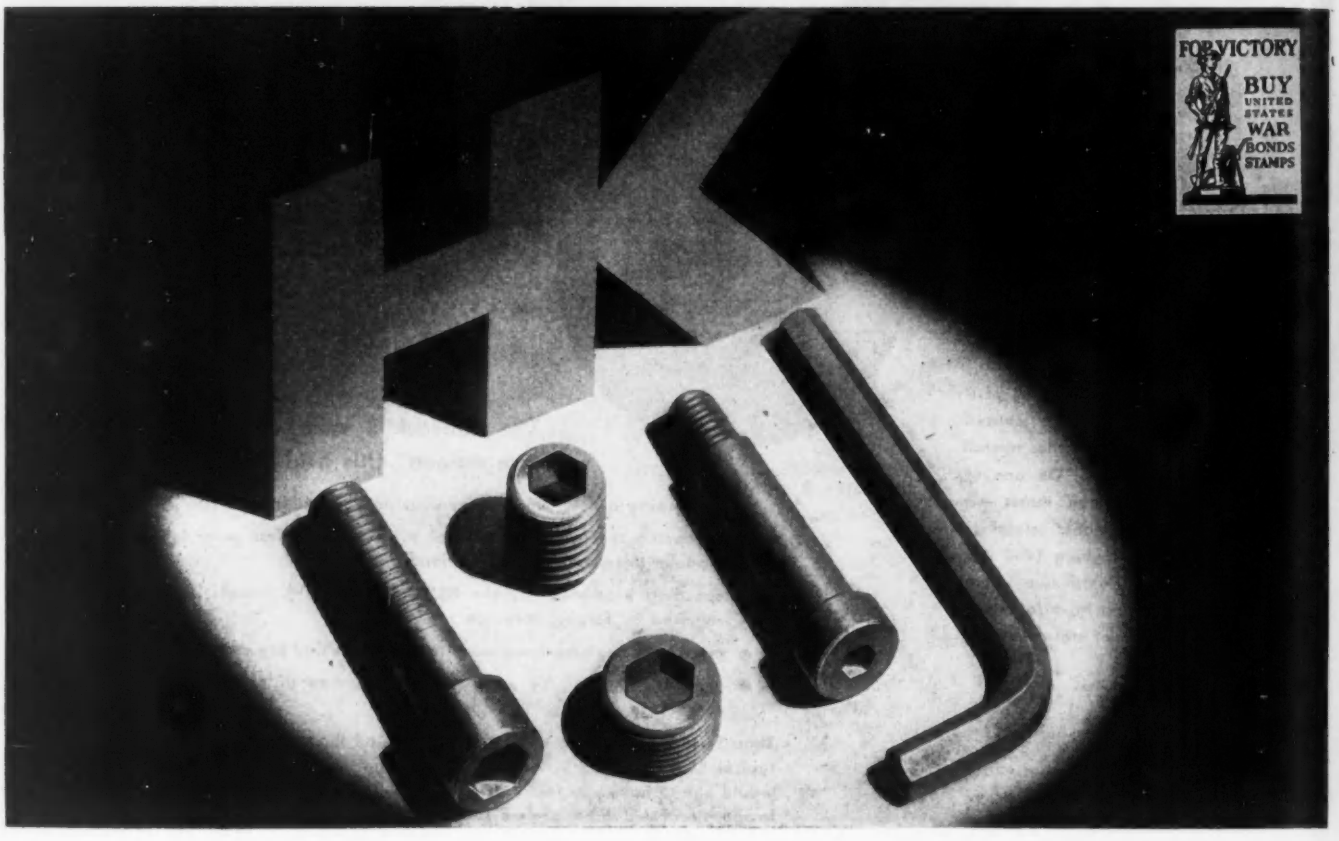
THE BABCOCK & WILCOX TUBE COMPANY

Seamless Tube Division
BEAVER FALLS, PA.

Welded Tube Division
ALLIANCE, OHIO

TA-1308

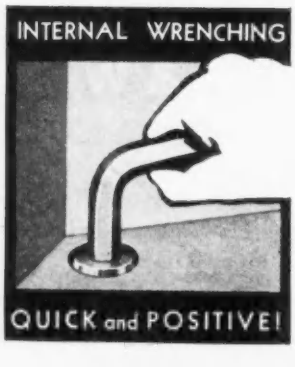
√Completely Cold Forged



fibro forged SOCKET SCREWS

by HOLO-KROME

√ METHOD PATENTED, OWNED, CONTROLLED, EXCLUSIVELY USED BY HOLO-KROME.



. . . . THE BETTER FASTENING METHOD

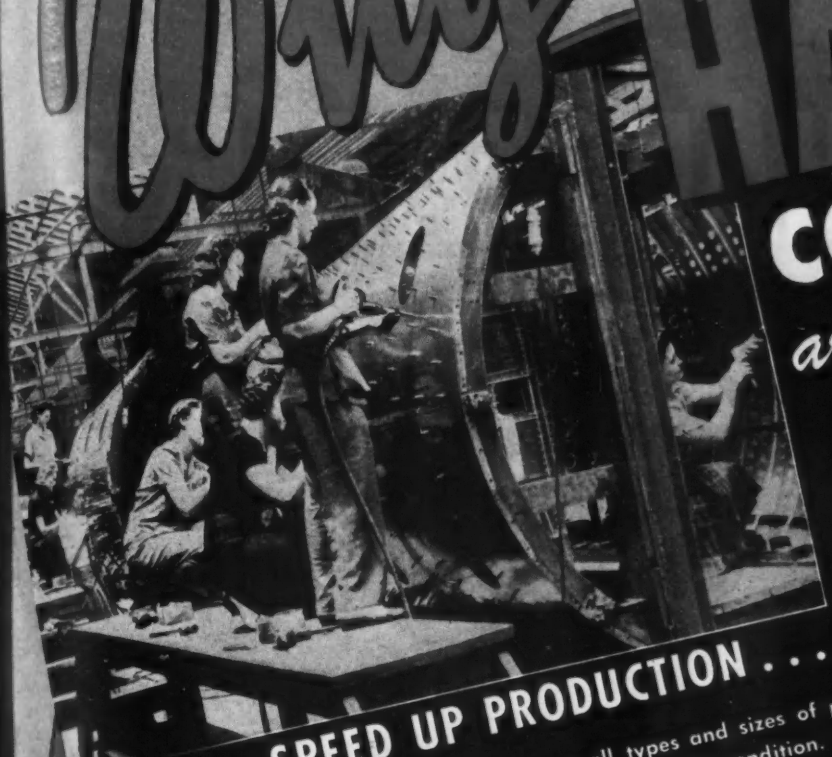
guaranteed unfailing PERFORMANCE

THE HOLO-KROME SCREW CORP.
HARTFORD 10, CONNECTICUT, U. S. A.

Why HANSEN COUPLINGS are so widely used

★

THEY'RE EASIER TO HANDLE, FASTER, LONGER LIFE, CUT DOWN COSTS



SPEED UP PRODUCTION . . .

Hansen Couplings are first choice in all types and sizes of plants throughout the world because of their remarkable performance under every conceivable condition. • Simplicity in design means faster and easier operation, greater production, less cost, less trouble, longer life. • Hansen Couplings will take pressures from 2 ounces to over 10,000 pounds without leaking. • They take rough treatment like a major because no parts are exposed, there's nothing to bend, jam or freeze. • Simplicity in operation is one Hansen feature that saves time, a lot of time. For instance, with a Hansen Air Coupling you merely push plug into socket, it is connected, locked and air is automatically turned on. To disconnect, merely slide sleeve back, it is unlocked, disconnected and air is automatically turned off.

There's a Hansen Coupling made for air, oil, grease, gasoline, oxygen and acetylene. Send in for free industrial catalog.

THE HANSEN MFG. CO.

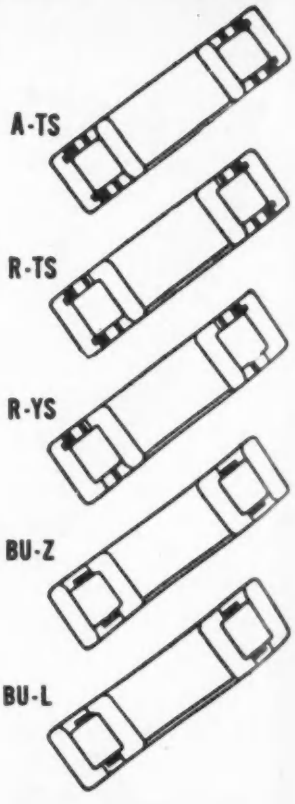
1786 E. 27th STREET • CLEVELAND 14, OHIO

SEND FOR *Free* CATALOG

Hyatt Hy-Load Bearings are made in separable types as well as in self-contained units. In the separable bearings the inner races are the separable units in one instance and the outer races in the other. Thus, the component parts of every separable Hyatt Hy-Load type bearing of a given size are fully interchangeable. Every race fits every roller assembly.

Separable races may be assembled in one part of the shop and the rest of the bearing in another. When the sub-assemblies are brought together on the final assembly line the component bearing parts will fit correctly. No selection or matching required.

Every Hyatt A-TS, R-TS, R-YS, BU-Z and BU-L type bearing has this feature—and many others. Write for data.



HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION

Harrison, New Jersey • Chicago • Detroit • Pittsburgh • Oakland, California

It all started

nearly a century ago. First the rubber, paper and sugar industries came to us for rolls. Then, as our reputation spread, others followed suit.

In most cases they simply said, "We need rolls. These are the production problems. Can you help us?" It was our job to make recommendations; then to design and build the roll we felt would meet the individual need.

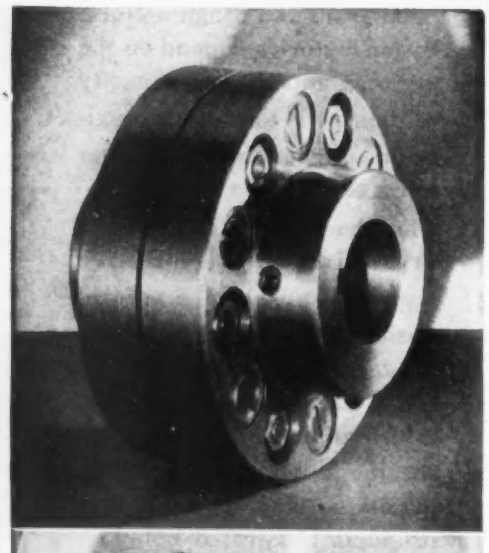
This was not an easy assignment. Each industry's problems were different — and constantly changing. At one end of the list is the paper industry, requiring, for example, reverse coating rolls, round and straight to within *one-half of one ten-thousandth inch,* or giant calender rolls twenty-five feet in length having a perfectly graduated increase in diameter from ends to center of *sixty thousandths of an inch,* ground with a high finish.

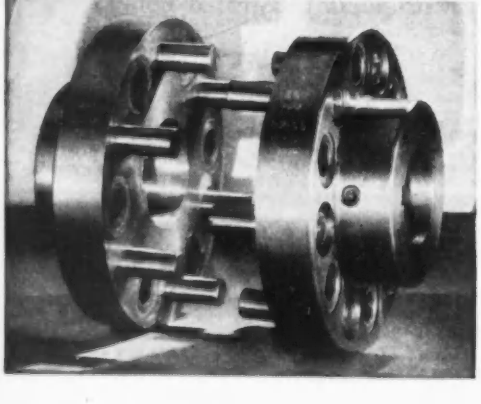
In direct contrast are the rolls required for crushing and grinding sugar cane. Here a special metal mixture is used to produce a hard iron of open grain and rough texture. Sugar factories depend on the gripping and feeding capacity of their rolls to provide maximum extraction and greater tonnage.

The chances are that, if you are using rolls, you have heard of some of the accomplishments of *America's largest specialty roll shop* at Ansonia, Connecticut. Write for information about rolls for specific applications, or for details of any of the other products illustrated below.

Farrel-Birmingham

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.
Plants: Ansonia and Derby, Conn., Buffalo, N. Y.





Try and Do It!

Just try to hold a couple of pencils in perfect alignment without touching each other, and see what happens.

This 10-second test will quickly show you why a flexible coupling is mighty important to the life of direct-connected machines.

Ajax Flexible Couplings provide a positive but resilient connection between driving and driven shafts. They make it possible for each shaft to rotate around its own axis without creating vibration, chatter, strain on bearings, drag, power loss, reversal of torque and other detrimental features.

Ajax interlocking drive studs held by rubber-bushed, graphited bronze bearings assure maximum flexibility, quiet operation, and complete elimination of lubrication problems.

Make the 10-second "pencil test"—then write for Facts on Ajax Flexible Couplings.

ARMY E NAVY

AJAX

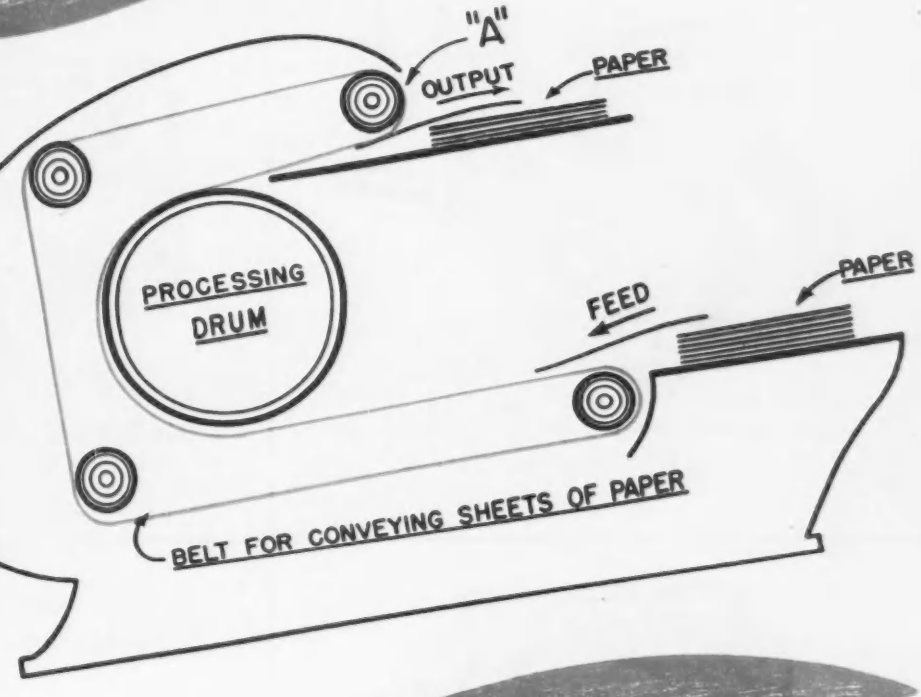
FLEXIBLE COUPLING

Incorporated 1920

WESTFIELD, N. J.

PROBLEMS THAT COME TO GILMER

"How can we get rid of static electricity in our conveyor belts?"



• Our customer had a machine application which involved the passage of very thin sheets of paper over a series of conveyor belts and through a processing machine. It was necessary that the paper leave the belt freely, and without marking, smudging or wrinkling.

Feeding the paper into the machine, and conveying it through the process, functioned smoothly until the paper reached point "A", indicated on the diagram above. Because of static electricity, the paper adhered to the belt instead of being released, and at times would feed back into the machine.

Since a normal rubber belt generates a considerable charge of static electricity, a change in the composition of the rubber seemed apparent. After some research, Gilmer engineers developed a new, static-free compound—and the problem was solved. Today, static-dissipating construction can be furnished in Gilmer V-Belts as well as Flat Belts.

The long experience of Gilmer engineers in the solution of belting and machine design problems may prove equally helpful and valuable to you.

GILMER makes a complete line of power-transmission and small conveyor belts. V-Belts, FHP and multiple; Flat Belts; Round Endless Belts; High Speed Belts; Fabric Belts; Planer Belts; and Special Endless Belts.

L. H. GILMER COMPANY

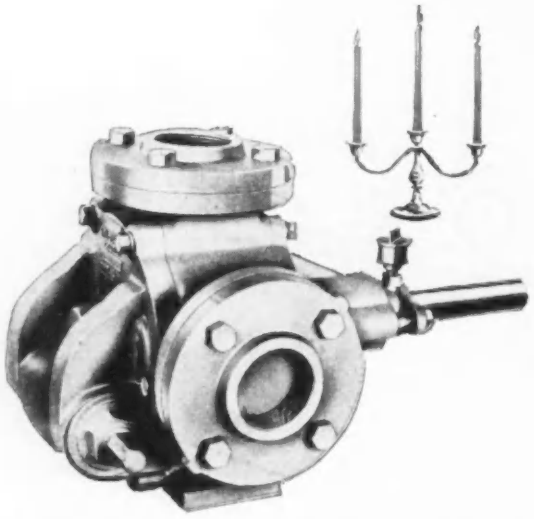
Tacony, Philadelphia 35, Pa.

DIVISION OF UNITED STATES RUBBER COMPANY

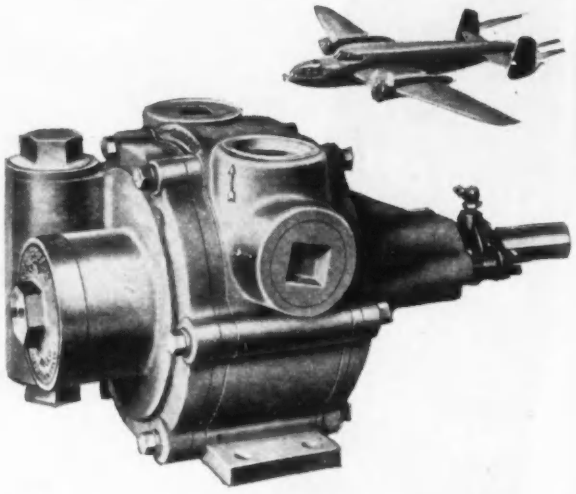
Gilmer BELTS

HOT OR HIGH...WAX OR OIL...

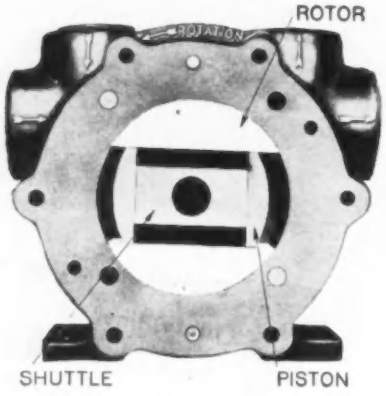
Here's Smooth, Economical Pumping

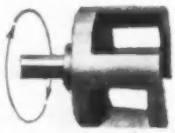


Yale & Towne TRI-ROTOR pumps liquid wax for a New York candle manufacturer . . . at 170°F.

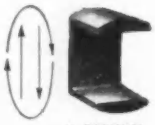


Yale & Towne TRI-ROTOR Turbo-Supercharger Lubricating Oil Pump for stratosphere flights.





A ROTOR



A PISTON

A SHUTTLE

Gives You Positive Handling of a Piston Pump with Power Economy of a Rotary Pump

That's why Yale & Towne's Tri-Rotor Pump is the *only low pressure pump* that gives highest volumetric efficiency on either thin or viscous liquid without chewing, foaming, aerating or overheating product.

Only 3 moving parts, 2 pumping members, so maintenance costs are low.

Sizes and models for delivering 5 to 200 G.P.M. Exclusive features (optional and interchangeable): Variable Volume Control, Manual Flow Control, Integral Relief Valve or Solid Head.

Yale Tri-Rotor Pumps can be shipped promptly on AA-5 priority or better. Orders calling for electric motor drives which require AA-2X rating or better may be slightly delayed. Send your order or write for complete information today.

Makers of the famous Yale Line of Locks, Hardware, Hoists and Industrial Trucks

TRADE **YALE** MARK

PUMP DIVISION OF

THE YALE & TOWNE MFG. CO.

Stamford, Conn., U. S. A.

Wire or air mail your requirements, (present or post-war) to Pump Division,
THE YALE & TOWNE MFG. CO., 211 Henry Street, Stamford, Conn., U. S. A.

AVAILABLE NOW—Increased facilities and the latest manufacturing methods permit our making prompt deliveries of pumping units on orders carrying properly executed priority certifications. (There may be a short delay when electric motors are required).

The Yale & Towne TRI-ROTOR Pump is now in use pumping such products as these (check application which interests you)

☐ Alcohol	☐ Fish Oil	☐ Lacquer	☐ Shortening
☐ Caustics	☐ Gasoline	☐ Liquid Soap	☐ Silicate of Soda
☐ Chocolate	☐ Glucose	☐ Molasses	☐ Solvents
☐ Coolants	☐ Grease	☐ Oils	☐ Starch
☐ Corn Syrup	☐ Ink	☐ Paint	☐ Varnish
☐ Edible Oils	☐ Jam	☐ Propane	☐ Viscose

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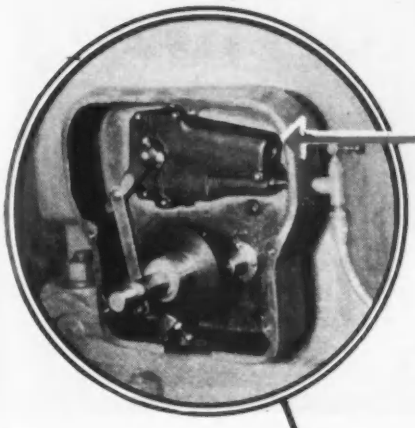
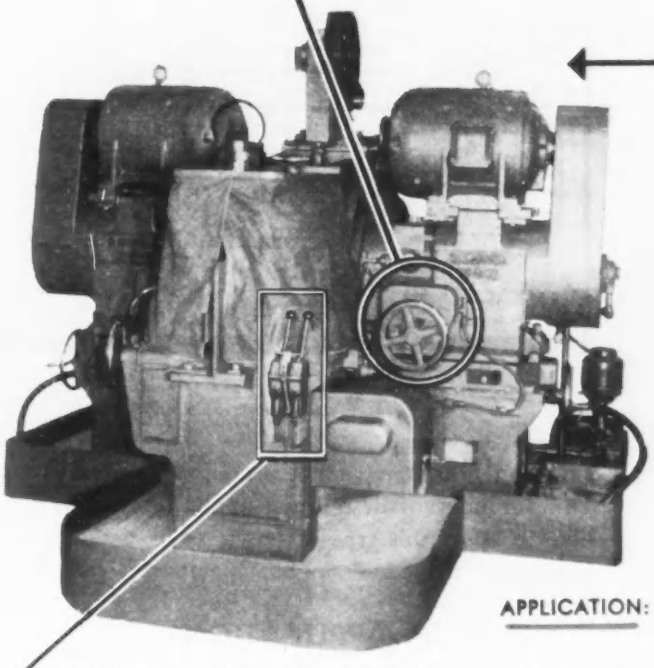
SPERRY HYDRAULIC REMOTE CONTROLS for the MACHINE TOOL INDUSTRY



SPERRY'S HYDRAULIC CONTROLS **minimize design problems by means of a single connecting tube that can be bent around corners and obstacles, or installed through walls, thus reducing design, installation, and maintenance costs.**



TRANSMITTERS ARE EASILY LOCATED IN MOST ADVANTAGEOUS POSITION

The machine shown at the left is a No. 84B-30" GARDNER DOUBLE SPINDLE PRECISION GRINDER, manufactured by Gardner Machine Company, Beloit, Wisconsin. On top the canvas spray protection hood are several bearing races ground by this machine; turned out at high rates of production and to extremely close tolerances. 4" diameter races are ground at a rate of 40 per minute, holding ground surfaces to .0003" to .0005" of parallelism.

APPLICATION: Remote Control of operating feed on Gardner Double Spindle-Precision Grinder.

PROBLEM: Original specifications called for Solenoid operated feeds. Initial installation presented the following difficulties:

a. Feed operated with too much shock on feeding mechanism.
b. Could not be relied upon to hold such necessary close infeeds as .0001".

SOLUTION: The Gardner Company changed to Sperry Hydraulic Controls with the following results:

a. Fast, smooth and shockless operation of infeed mechanism.
b. Hydraulic Control sensitivity eases the operation of infeed mechanisms.
c. Operator fatigue lessened due to one-position, centralized control.
d. Low maintenance and trouble-free operation of controls.

The above case-history is typical of the advantages secured by many Machine Designers and Product Engineers when they use Sperry's single-tube system to solve their remote-control problems.

EASY INSTALLATION
DEPENDABLE
ACCURATE

SEND FOR BULLETIN 78 FOR ADDITIONAL DETAILS

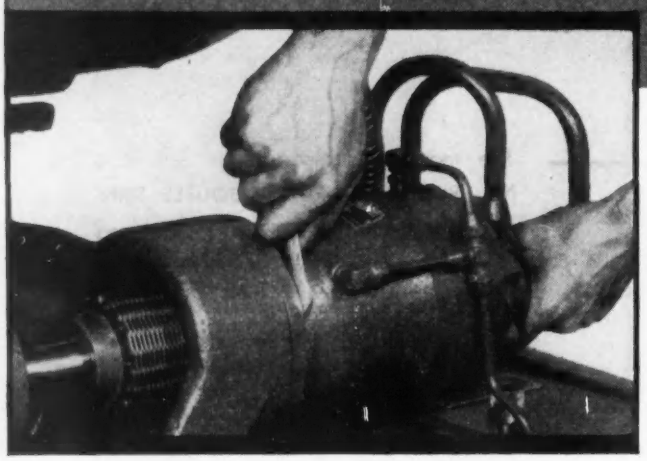
SPERRY

For Scientific Achievement

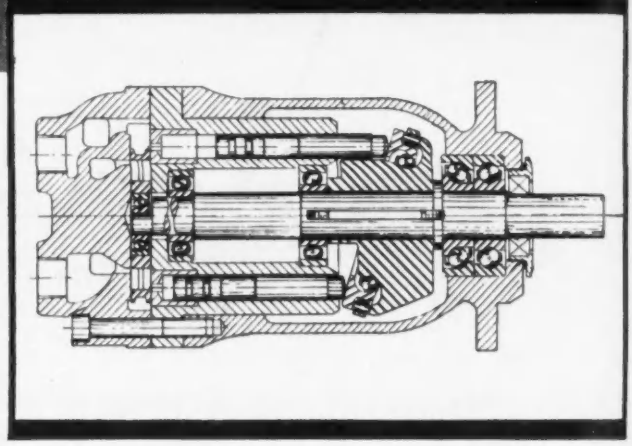
SPERRY PRODUCTS, INC.

HOBOKEN, N. J. CHICAGO, ILL.

To the Designer Who Hasn't Discovered the Advantages of A SUNDSTRAND FLUID MOTOR



Compact design and ease of assembly are two features of Sundstrand fluid motors.



Simplicity of design, fewer parts, and automatic lubrication reduce maintenance expense.

A fluid motor in a power transmission system eliminates the necessity for complicated gearing and clutch mechanisms for changing speeds. An infinite range of speeds, within range of motor, is available and speed changes can be made while the unit is in operation. It's easy to get that wide speed range with this high torque, compact motor.

HOW THEY OPERATE

Fluid motors obtain their power from oil under pressure. This is usually transmitted through oil lines from a properly designed pump controlled by pilot or solenoid valves. Controls may be manual or automatic as desired.

ELIMINATES LONG SHAFTS . . . GIVES SMOOTHER FEEDS AND SPEEDS

Sundstrand fluid motors are compact, require very little piping to mount close to driven member. This eliminates jerky feeds through possible windup of long drive shafts. The simplicity of design and application makes it possible to apply this type of power transmission where a wide speed range and smooth operation is required.

TYPICAL APPLICATIONS

of the Sundstrand fluid motor include lathes and milling machines requiring high torque for heavy turning and milling cuts, duplicating machines requiring smooth and extremely sensitive operation at all speeds, grinding machines, road machinery, and many others.

The fluid motor lends itself to most any power transmission requirement. Our engineers will be glad to assist in determining how to use it to best advantage in your designs. Call on them without obligation.

FREE **DESIGN AND APPLICATION DATA**

This 8 page bulletin contains the information you'll need in adapting the Sundstrand fluid motor to your design. Write today.

Ask for bulletin 113.

SUNDSTRAND MACHINE TOOL CO. · ROCKFORD, ILLINOIS U.S.A.

SUNDSTRAND PUMP DIVISION

2556 ELEVENTH ST., ROCKFORD, ILLINOIS

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At any rate we have *four* great plants making products in *four* classifications . . . they are in use today in every corner of the globe.

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Standard Products laboratories and engineering division are at your service, if you have a steel stamping, molded rubber or plastic molding problem submit necessary data and our engineers will present designs and proposal.

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Main Offices and Research Laboratory

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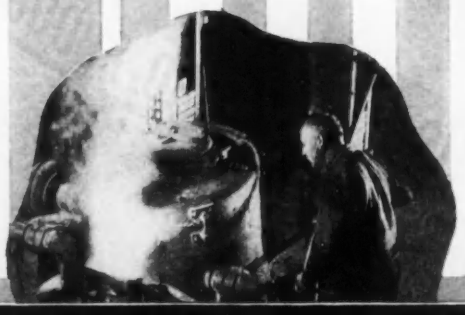
SEYMOUR



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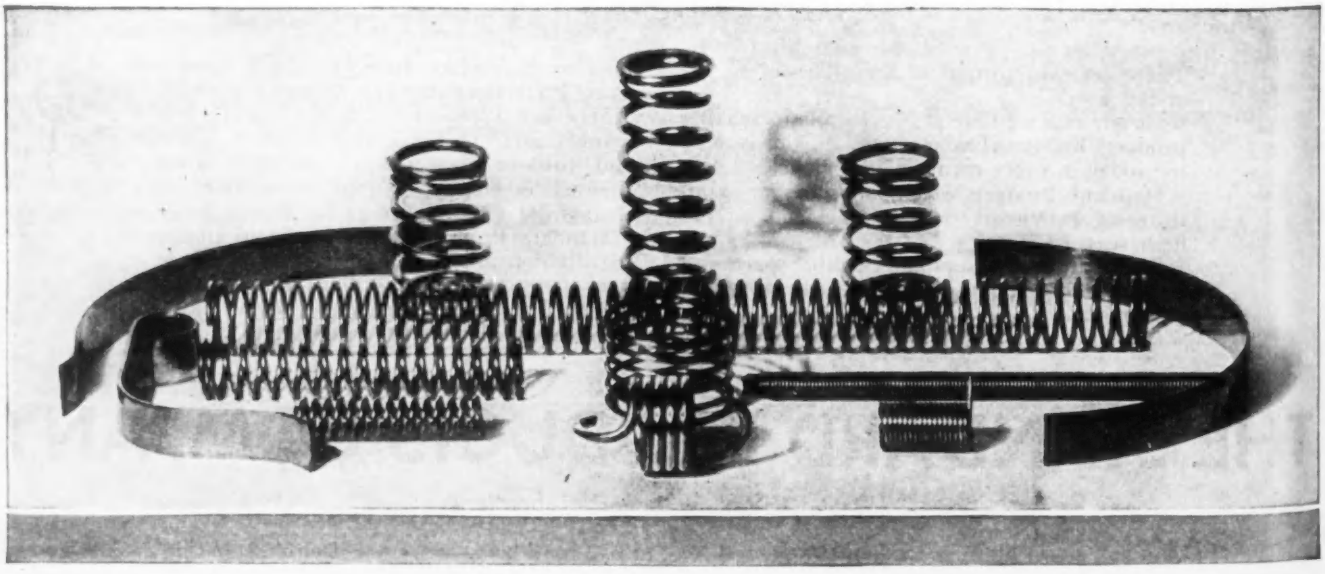
Just a fraction of a percent of phosphorus converts a copper-tin mixture into "phosphor bronze"—an alloy unlike either of its constituents. Toughness, lasting resilience and high corrosion resistance immediately become its major characteristics. These qualities make it an excellent material for springs in electric snap switches, meters, measuring instruments and innumerable other devices that must function on their own, and often under extremely corroding conditions.

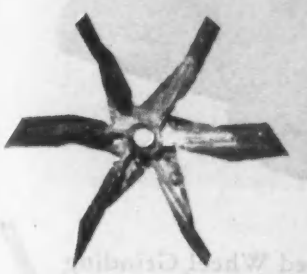
THE SEYMOUR MANUFACTURING CO., SEYMOUR, CONN.



COLMONOY
Sweat-On-Paste

Cement conveyor gudgeon

Cement mill clinker plow



Dust collector fan wheel

Cinder and cement block tamps

Rough and Tough
ROCKWELL C68-72

● If you need hard-facing that's really tough—use Colmonoy Sweat-On Paste, which has the greatest abrasion resistance of all Colmonoy hard-facing materials.

Its extreme hardness makes it ideal for so called "rough" applications, such as those shown here, in addition to many military uses which can neither be illustrated nor described.

Colmonoy Sweat-On Paste is easily applied, the application consisting of fusing into the base metal, by the carbon arc method, or the oxy-acetylene method where very thin overlays are required. Furnished in containers of one, five and twenty pounds.

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UNIVERSAL·OSCILLATING CHUCKING GRINDER

● This versatile grinder was designed to handle external and internal cylindrical and conical surfaces, generated or formed spherical external and internal surfaces and generated or formed annular surfaces, such as ball bearing races and fillets.

In addition, this machine grinds combinations of the above in a single set-up, insuring both extreme accuracy and perfect blending of curved with straight surfaces.

The construction incorporates many features that result in accurate, fine finish, and low production costs —heavy, vibration-free base; precision preloaded bearings for vertical oscillating spindle, work head spindle and grinding wheel spindles, grinding spindles dynamically balanced; quick acting clamping attachments for collets or diaphragm chucks; micrometer feed screws for work head set-up and grinding wheel spindle; adjustable diamond wheel trueing devise.

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Investigate the complete line of GEARGRIND Machines for the Formed Wheel Grinding of external and internal gears, external and internal involute splines, straight splines, serrations and racks. Also special GEARGRIND Machines for special grinding operations.

CONTRACT GRINDING SERVICE

ARMY (E) NAVY

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DETROIT 11, MICH. U.S.A.

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Forging Assignments Licked with "Es"

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EQUIPMENT

EXPERIENCE

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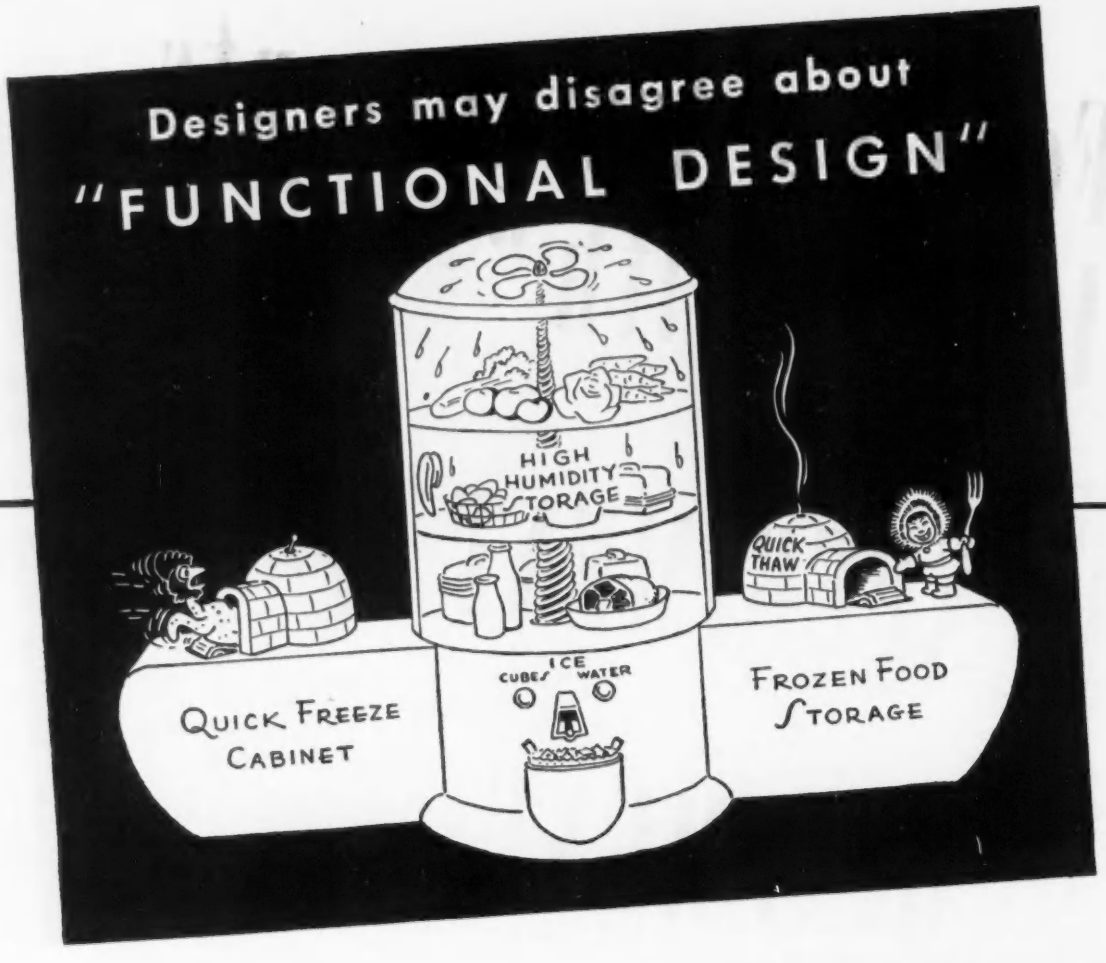
Tube Turns will welcome your inquiry. Complete laboratory facilities and a resourceful engineering staff are at your service. Our equipment is capable of vast quantity production, with accurate heat treating under rigid control.

Because of the "E's" with which Tube Turns has handled many forging assignments, it is possible for us to suggest forgings for uses where, formerly, they would have been out of the question. Write to us about your problem. TUBE TURNS (Inc.), Dept. PE-2, Louisville 1, Kentucky.

TUBE TURNS *Forgings for Industry*



. . . but they all know that any **REFRIGERATOR** MUST HAVE GOOD INSULATION

The need for various *degrees* and *kinds* of cold, to keep different foods at their best, may bring about some radical changes in the functional design of refrigerators—but none, let us hope, as radical as those illustrated above.

Irrespective of such new developments, tomorrow's refrigerators will need good insulation—insulation that will stand up and retain its insulation efficiency over a long period of time. In short, such insulation as Fiberglas*.

Being *inorganic* — made of fine fibers of glass—Fiberglas is a permanent and efficient insulation material, immune to rot and decay. It is highly moisture-resistant — picking up less than 1% by weight under extreme humidity conditions—and dries out without harm. It is not corrosive to aluminum and steel in the presence of moisture. Best of all, it won't settle or disintegrate, but stays put for life even when subjected to severe vibration.

The remarkable service rendered by Fiberglas Insulation in millions of ranges, refrigerators and other home appliances has made it a favorite with buyers, as well as with merchants and manufacturers. Its flexibility and easy handling qualities have also appealed strongly to appliance manufacturers, as has its light weight—a source of substantial freight savings for many companies.

Yes, there are many reasons why Fiberglas Insulation deserves a place in your Postwar Plans. For full information, write *Owens-Corning Fiberglas Corporation, 1850 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ont.*

ARMY E NAVY

FIBERGLAS *THERMAL INSULATION*

*T. M. Reg. U. S. Pat. Off.

THE NUT THAT UNTHREADED *Locks* ON STUDS!

Thirty-eight SPEED NUTS are pushed over integrally molded plastic studs in this radio panel assembly, eliminating threaded inserts, reducing mold costs and assembly time.

In fastening insulation to floor board in trucks built by the White Motor Co., SPEED NUTS 1-1/4" square pushed over No. 11 nails eliminate large washers or retaining strips.

THE BASIC PRINCIPLE
of Spring-Tension Lock is
Embodied in all Speed Nut Designs

● Just a push and it locks! It's just as simple and easy as that! For this unique spring steel fastener needs only to be *pushed* over rivets, nails, tubing, wire, integral die cast or plastic studs to lock parts firmly together. Threads are unnecessary because the spring prongs of the nut provide a friction *lock* on even the smoothest of chrome surfaces.

But easy attachment is not the only advantage gained by using Push-On type SPEED NUTS. Costly threaded inserts, drilling and tapping are eliminated—molding costs reduced—assembly speeded up—and vibration loosening prevented. These fasteners are available in many sizes and shapes . . . rectangular, square, round, or they may be specially designed to fit your particular requirements.

If you want to improve the attachment of name plates, emblems, trim strips, grilles, or other light-weight parts, write now for samples of Push-On type SPEED NUTS, giving *stud diameter* and any other pertinent assembly details.

TINNERMAN PRODUCTS, INC.
2041 FULTON ROAD, CLEVELAND 13, OHIO

In Canada: Wallace Barnes Co., Ltd., Hamilton, Ontario
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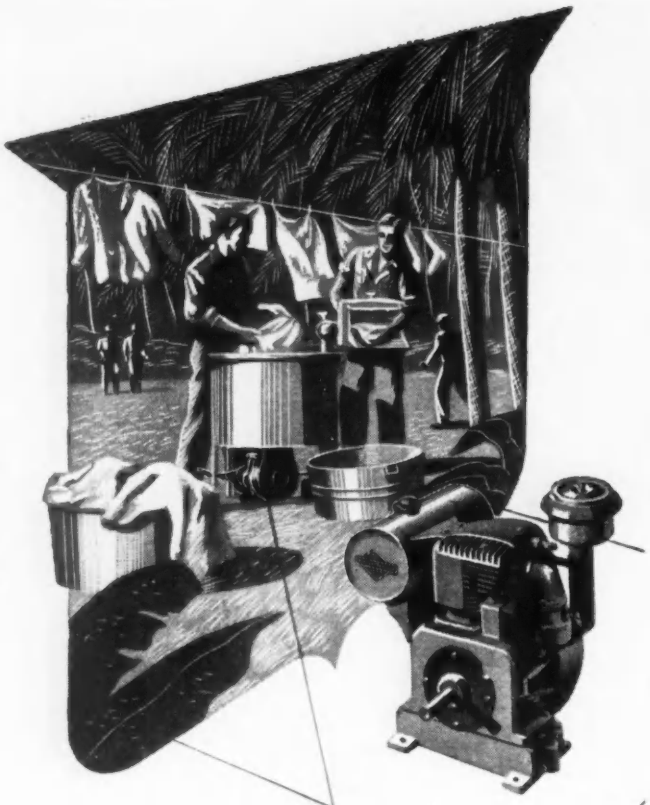
*Speed Nuts** PATENTED

*Trade Mark Reg. U. S. Pat. Off.

FASTEST THING IN FASTENINGS



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Air-Cooled Power 4 CYCLE BRIGGS & STRATTON GASOLINE ENGINES

Manufacturers, distributors, dealers, and users of all types of appliances, tools, and equipment requiring dependable, compact power units vouch for the performance record of Briggs & Stratton engines. The latest models are backed by the experience gained in twenty-five years of *continuous* production of more than 2,000,000 *Air-Cooled* Gasoline Engines. BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U.S.A.

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Chromium Nickel Alloys are readily formed cold, but a certain "Know How" is required, as stainless has certain characteristics that ordinary steels do not have . . . they are stiffer, harden quickly when worked in dies, and have a "spring" due to high elastic limit. So you must have the "Know How," what kind of dies, drawing compounds, press speed, pressures, etc.

We have it . . . been forming stainless for years. If stainless stampings are your requirements, send us your inquiries.

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The engineering and manufacturing experience of OLYMPIC—broadened and accelerated by wartime production schedules—will be available for peacetime requirements. Intricate designs are a specialty, and facilities include those for all phases of metal working—production tooling, stamping, forming, drawing, welding, brazing and soldering.
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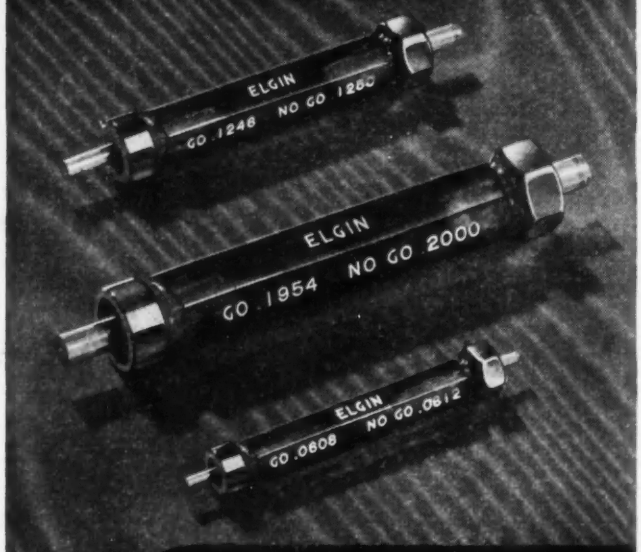

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MORE THAN

350 to 1!

WILL they *never* wear out . . . these Elgin Sapphire Plug Gages in use at a Stewart-Warner plant?

The one which has been used over the longest period has already delivered the incredible total of 110,000 gagings on forged steel parts . . . and still shows no wear! *Steel* plug gages, formerly used on the same kind of parts, averaged only 300 gagings each.

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So they put CONE-DRIVES *in Capstans*

By virtue of its tremendous load carrying capacity, Cone-Drive gearing can transmit more power for a given size.

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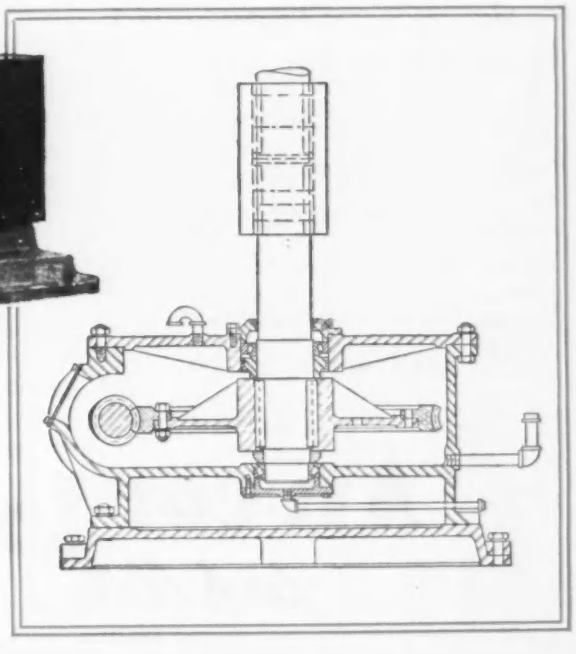

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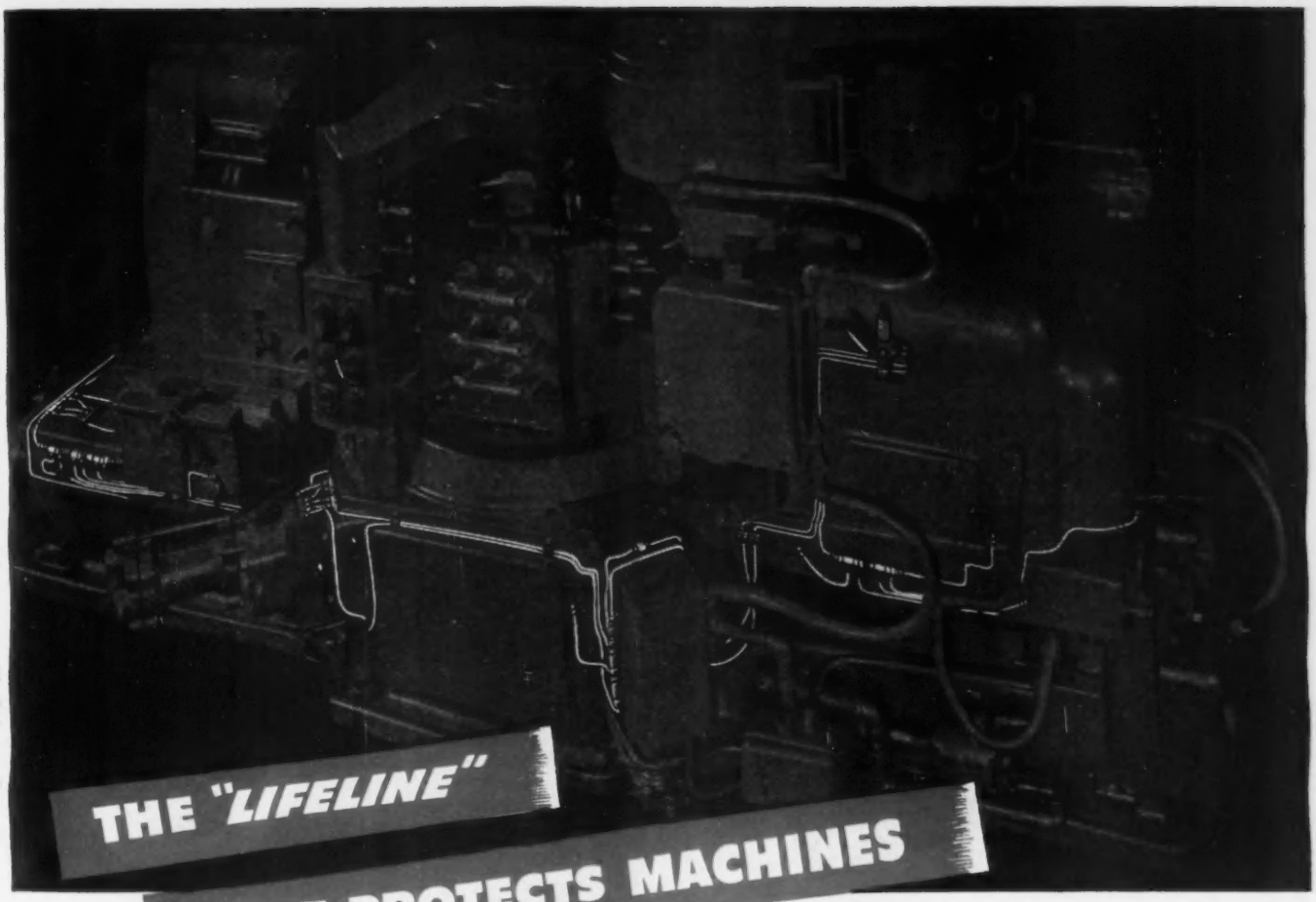
with re-use!

Field and laboratory tests show that An-cor-lox lock nuts (patented) increase in locking power with each re-use, under real operating conditions of vibration, shock, or impact. All the facts are presented in our An-cor-lox bulletin . . . sent you free, with An-cor-lox sample. Yours for the asking.

An-cor-lox
TRADE MARK REG
Lock Nuts

An-cor-lox Division
LAMINATED SHIM COMPANY
Incorporated
1879 63 Union Street • Glenbrook, Conn.



THE "LIFELINE" THAT PROTECTS MACHINES FROM COSTLY HUMAN ERROR

That machine of yours can die young if human error has its way. But there's a way to eliminate human error in lubrication. Make Centralized Lubrication a part of your machine when you build it. You'll be giving it a set of arteries that will keep it young and productive for years longer.

Alemite Centralized Lubrication Systems are actually "life insurance" for machines. Each bearing, no matter how remote, is given a positive delivery of a measured shot of grease or oil. Machines need not stop, for bearings are lubricated from a central point.

The four new Alemite Centralized Systems are adaptable to almost any type of machine. And here are the kind of results they achieve: a huge machine containing 500 bearings is now positively lubricated *while in operation* in 10 minutes per 24 hour day. Former lubrication time—2 hours every day and the machine had to be shut down!

There are many potent sales points added to machines when they are equipped with Centralized Lubrication. The need for costly field service is eliminated. And, through improved performance, your machines enhance your reputation as a designer.

Have a Demonstration of the 4 New Alemite Systems . . . Right at Your Desk

Without obligation, have an Alemite Lubrication Specialist call and demonstrate Centralized Lubrication with four transparent working models. You can study them at close range—actually work them yourself at your desk. If you like, the Alemite Specialist will gladly give you any technical help or information you may want regarding the adaptation of Alemite Centralized Systems to your machines. Drop a note on your letterhead to Alemite, 1808 Diversey Parkway, Chicago 14, Illinois.

Another Product of STEWART WARNER

ALEMITE

REG. U. S. PAT. OFF.

First in Modern Lubrication

CONSULTATION • ENGINEERING • EQUIPMENT • LUBRICANTS MAINTENANCE

We Make Your Blue Print Dreams Come True

Consider this example of Western skill that assures you precision parts at quantity production economy

Designers who planned this torque rod ball for heavy-duty trucks demanded extra-rugged strength to take a beating in war service and super-smooth finish to prevent binding or wear on its composition mating piece. So we turned and ground it from a rough forging of SAE 4340 steel, over 5″ long, 3″ diameter at the ball, better than meeting the specification of 8-12 micro inches profilometer reading on ball surface, a .004 total tolerance on diameter, accurate taper on shank and class three fit on threaded end. Down to precision parts of watch works size, you can depend on Western skill and ingenuity to produce them — with ultra-exactness, speed and economy. Prompt attention to your inquiry — it pays you to write us.

Western Complete Service — Special precision screw machine products to specifications. Capacity range, 1/16″ to 4 5/8″ round. Complete equipment for all types of secondary and processing operations — precision grinding, heat-treating, hardening, pentrating.

Western Automatic
Machine Screw Company
728 Lake Ave., Elyria, O.

Precision Parts and Assemblies Since 1873

Seamless

RINGS

Finest Forging, Rolling, Machining Equipment

Modern Laboratory to Verify Specific Characteristics

Complete Facilities for All Types of Heat Treating

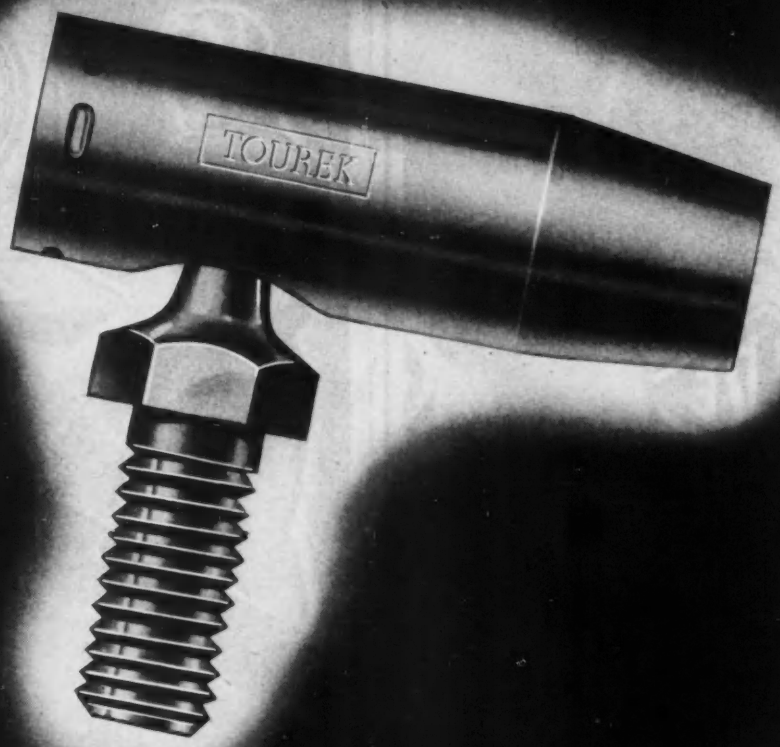
CARBON STEEL
ALLOY STEEL

● No matter how rigid the specifications, Taylor forged steel rings are uniformly high in quality. This is because Taylor Forge has both the "know-how" and the facilities, plus more than 40 years of experience in forging and rolling annular products. When you weigh sources of supply, weigh the skill and specialized knowledge Taylor puts at your command. Inquiries are invited.

Forged and Rolled by TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS
General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church St.
Philadelphia Office: Broad Street Station Bldg.

Other Taylor Forge Products include: "WeldELLS" and related seamless fittings for pipe welding; forged steel flanges; forged steel nozzles and welding necks for boiler and other pressure vessel outlets; light wall spiral pipe; heavy wall electric-weld and forge welded pipe; corrugated furnaces, and similar forged and rolled products.



TOUREK BALL JOINTS...
the recognized standard!

Manufacturers throughout the nation look to Tourek to supply their requirements for ready-made ball joints in many different styles and sizes.

For nearly twenty-five years Tourek *famous* Ball Joints have led in design and performance... their acceptance by major industries everywhere has long established them as *the recognized standard!*

Tourek's broad experience, engineering ability and production facilities are at your disposal to design and manufacture special ball joints to meet your particular applications.

Write today for complete data about Tourek *famous* Ball Joints.

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4701 W. 16TH STREET, CHICAGO 50, ILLINOIS

MAKERS OF PRECISION SCREW MACHINE PRODUCTS

ESTABLISHED 1920

TOUREK

FAMOUS BALL JOINTS

This Seal of Merit Symbolizes the Solution to your Sealing Problems

Seal rings developed by Pure Carbon are meeting the most exacting demands for efficiency. In applications where low friction, non-abrasive and long-lasting seal rings are a necessity, our carbon seal rings are demonstrating their superiority to the complete satisfaction of increasingly more manufacturers. Consult the Pure Carbon engineer in or near your city. He'll gladly co-operate with you in working out the answer to your sealing needs.

SEND FOR NEW BOOK DEFINING USES OF CARBON SEAL RINGS

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Pure Carbon Co., Inc.
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NIBCO WROT Fittings

WHEN designing new equipment for low production cost, remember NIBCO WROT and Cast Fittings and Valves or special tubular parts. Accurate manufacture and perfect sizing make alignment easy and save time. Formed in one step from straight copper, aluminum or stainless steel tubing under tremendous pressures . . . they are the finest solder fittings made . . . vibration-proof and impervious to gases. Not only are tolerances maintained by individual plug tests, but all NIBCO products are manufactured under strict Laboratory Control. Write for catalog and get acquainted with the many items in NIBCO's line that will help solve your design problems.

NORTHERN INDIANA BRASS CO.
ELKHART, INDIANA
VALVES AND FITTINGS SINCE 1904

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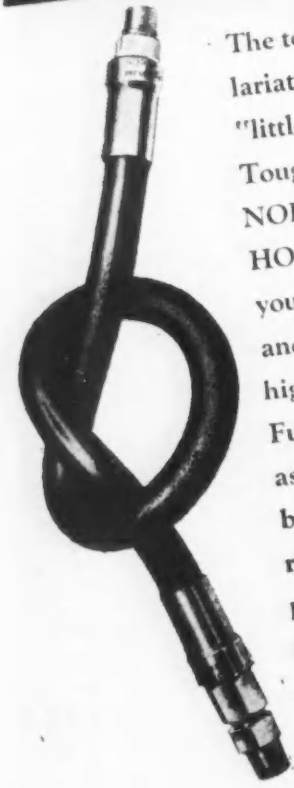
AIR AND HYDRAULIC DEVICES
Yes, it's true!
RUPPERT ESSER, THURLOW WITTERS, DON THOMAS, JACK MARSH, T. D. WITTERS, BOB EARLY, and others, representing over 100 years of experience in the engineering and manufacture of air and hydraulic devices, are busily engaged with me in the production of an advanced line of products. But more on that in the next issues of this magazine.
JOHN C. COTNER
VICE PRESIDENT
GEROTOR MAY CORP.
GEROTOR MAY CORP., Baltimore, Md. — LOGANSPORT, IND.

Limber as a Lariat
STRONG as STEEL!



The tough flexibility of a lariat is sure control for "little dogies."

Toughness and flexibility in NORGREN INDUSTRIAL HOSE ASSEMBLIES gives you equal control over heat and cold, oil and vibration, high and low pressure.

Full line of Norgren hose assemblies, with machined bar-stock fittings, covers all requirements, hydraulic or pneumatic. Write for information, giving your specifications.

C. A. Norgren Co.,
220 Santa Fe Drive,
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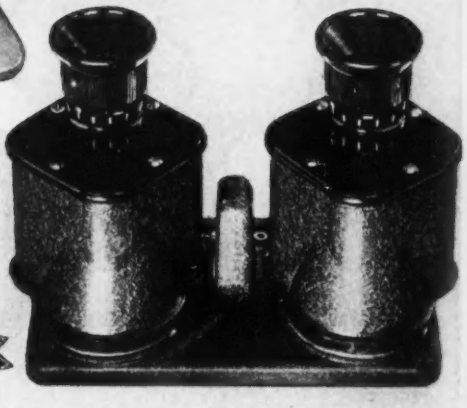
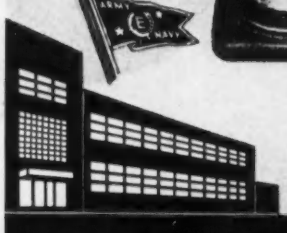
Norgren

"SEEING'S BELIEVING" with BINOCULARS that are 100% Die Cast!

All parts—except lenses—in these Army stereoscope binoculars are die cast of zinc alloy. The result — a precision instrument, involving close tolerance work, produced complete and at nominal cost through die casting . . . the only method found to be economically feasible.

It's another instance of how Mt. Vernon engineers apply their knowledge, skill and ingenuity to the solution of unusual problems. Why not consult us? Perhaps you can use our talents, too!





MT. VERNON
DIE CASTING CORP.
MT. VERNON, NEW YORK

HERE TODAY— AND HERE TO STAY . . . .

New Standards of Brazing Speed, Quality and Economy set by

SIL-FOS and EASY-FLO

Typical of the wide-scale use of SIL-FOS and EASY-FLO in mass production brazing is this engine-thermo-couple job. With the simple EASY-FLO brazing set-up shown, using foot-controlled carbon electro heating, 180,000 assemblies were completed in fast time. Insulation was undamaged, thanks to EASY-FLO's low flow point.

These two low-temperature silver brazing alloys, created by Handy & Harman, have made a record, particularly in war production, that is outstanding.

SIL-FOS and EASY-FLO have made brazing one of the fastest production operations. They have set new standards in the strength and other vital properties of brazed joints. They have created a new conception of brazing reliability and economy. They have made practical the labor-metal-cost-saving brazed construction, now used in fabricating a wide variety of parts formerly cast, forged, machined from the solid, bolted, threaded or riveted.

These accomplishments are the direct results of the combination of low working temperatures, silver content and exceptional fluidity inherent in the SIL-FOS and EASY-FLO compositions, plus fast heating and handling methods.

These new SIL-FOS and EASY-FLO brazing standards of speed, quality and economy are here to stay. They will be just as important in tomorrow's peacetime production as they are today. So, start now to put your brazing operations, old and new, on the fast, profitable SIL-FOS and EASY-FLO basis.

GET FULL DETAILS IN BULLETIN 12-A

Write for your copy today

FOR BEST RESULTS—USE HANDY FLUX

To get full benefit of the low flow points of SIL-FOS (1300°F.) and EASY-FLO (1175°F.) you need a flux that also functions at a low temperature. HANDY FLUX was developed by Handy & Harman to meet this requirement. It starts to fuse and dissolve oxides at 800°F., and at 1100°F., is entirely fluid, and dissolves all refractory oxides rapidly and completely. HANDY FLUX has excellent cleaning properties and washes off readily in hot water after brazing. Comes in convenient paste form.

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HANDY & HARMAN FOUNDED 1867 QUALITY SERVICE

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Your
ASSEMBLY SAVINGS
also
CUT SERVICING TIME

THE HOURS YOU SAVE in factory assembly by simply *peeling* precision laminations for accurate fitting of machine parts will be repeated by your users on every service adjustment. Want performance data and photo chart of applications?

Laminum shims are cut to your specifications, but shim materials for repair are sold through your industrial distributors.

Laminated Shim Company, Incorporated
63 Union Street • Glenbrook, Conn.

LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT

2215

MACHINE DESIGNERS themselves have developed these applications of the MOTOAIR PUMP

HOLDING FABRICS OR PAPER FOR ACCURATE BONDING SLITTING or WINDING

PUMP PRIMING FOR DEEP LIFTS

VACUUM FILLING

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POWER for CHUCKS or VISES

LIFTING & CONVEYING SHEET-METAL PARTS FOR DIE-STAMPING or ASSEMBLY

PAPER HANDLING

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NO GEARS
NO DRIVES
NO GUARDS
NO BELTS

VACUUM OR PRESSURE

Motor and pump in one integral unit takes less space; permits ceiling, wall or normal mounting of pump.

Hundreds of these dependable Pumps are being used by Government and Industrial Plants, as stationary or portable units.

NEW JERSEY MACHINE
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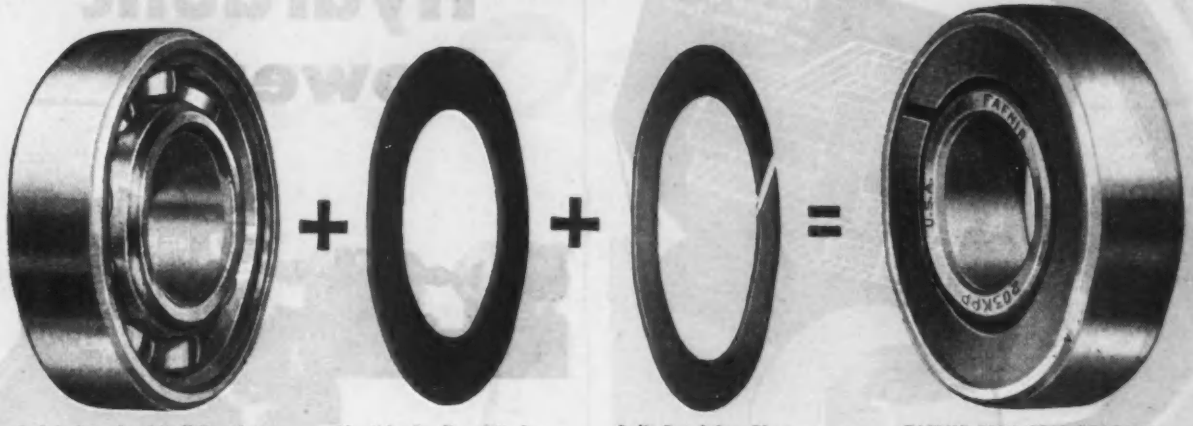
CINCINNATI, OHIO

Write for Catalog!

FAFNIR PLYA-SEAL BALL BEARINGS

Performance Proved in Military Equipment • Now Available for General Use



Fafnir Standard Ball Bearing — Flexible Sealing Washer — Split Retaining Ring — FAFNIR PLYA-SEAL BEARING

POSITIVELY SEALED — SEALS EASILY REMOVED

THE result of five years of development and testing, PLYA-SEAL bearings have proved the most effective, self-protected bearings yet designed. Approved for aircraft by the Army Air Forces and the Bureau of Aeronautics U. S. Navy, Fafnir PLYA-SEALS have been in use successfully for over two and one-half years in aircraft control bearings and operating equipment. Several thousand bearings incorporating the double PLYA-SEAL have completely eliminated former difficulties with metal shielded bearings in textile machines.

Whether you are designing a new product or planning to resume production on an old one, you will find it very much worthwhile to investigate and test Fafnir PLYA-SEAL Bearings. Write for complete descriptive folder. The Fafnir Bearing Company, New Britain, Conn.

PLYA-SEAL takes its place among these other FAFNIR "FIRSTS" . . .
Wide Inner Ring Ball Bearing with Self-Locking Collar; Seal and Shield Type Bearings; Compact Super-Precision Spindle Bearings; Compact Super-position Retainers, Aircraft Ball Bearings, Rubber Pillow Blocks . . . and more.

WHAT IS PLYA-SEAL?

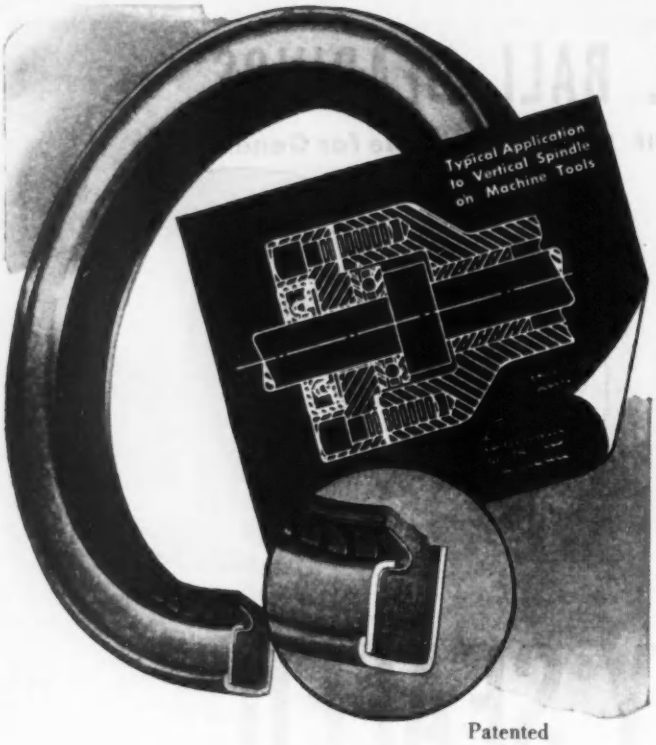
A diaphragm-type, contact seal comprised of two members – a flat, flexible sealing washer of synthetic rubber impregnated fabric and a split retaining ring of stainless steel.

Firmly held in the outer ring, the sealing washer does not rotate with the inner ring but is in contact with a ground groove to form a very effective seal with a minimum of friction.

WHAT ARE PLYA-SEAL'S ADVANTAGES?

1. Assures maximum retention of lubricant, maximum exclusion of dirt and liquids.
2. Causes no distortion of the outer ring or race, nor does it affect the concentricity of either the rings or races.
3. Forms a positive seal with the outer ring while maintaining perfect contact with the inner ring.
4. Non-capillary and impervious to liquids, grease, oil, gasoline, water and a wide variety of solvents. Not affected by heat or cold. Sealing washer does not deteriorate with age.
5. Easily removed and replaced to allow inspection, washing and re-greasing.

FAFNIR
BALL BEARINGS



Patented

Tough... Resilient ... Durable

The exclusive Garlock compound used in the sealing ring of the KLOZURE Oil Seal is non-porous and non-abrasive—in addition, it is tough, resilient and durable. It resists heat and oil. Even after long service the KLOZURE sealing ring is as firm and resilient as when applied and the wearing edges remain clean and sharp. Complete range of sizes including metric O. D. to fit bearing manufacturers' standard bore sizes.

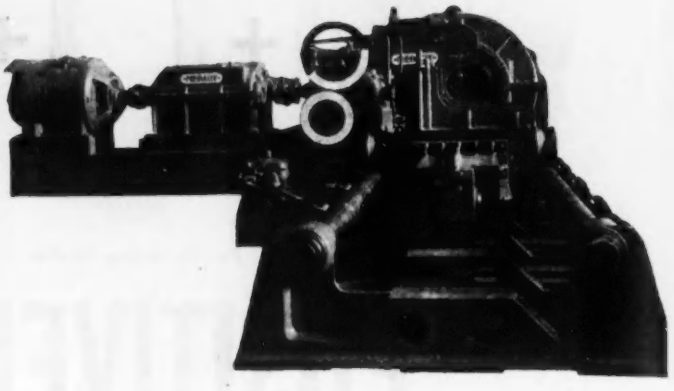
Write for catalog

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Limited, Montreal, Que.

Garlock
KLOZURE OIL SEAL

Hydraulic Power



for the largest billet peeler

This Medart rotary cutter billet peeler will turn the outside of rolled or forged bars up to 13 inches diameter, and is the largest machine of its type in the world.

Two hydraulic grip carriages on input and output sides clamp the billet. The carriage is moved forward by a large hydraulic cylinder.

Hannifin precision hydraulic cylinders are used by Medart for both these applications. The carriage cylinders are 11 inch bore x 144 inch stroke, an example of Hannifin ability to build large, long stroke cylinders to precision standards. All Hannifin hydraulic cylinders, large or small, are bored and honed to produce a mirror-finish cylinder body—for maximum power, smooth action, and long life.

Write for Bulletin 35 describing Hannifin hydraulic cylinders. Hannifin Manufacturing Company, 621-631 South Kolmar Ave., Chicago 24, Illinois.

Hannifin
HYDRAULIC CYLINDERS

N·B·M SILVER BABBITT
Eats Dirt

Dust, dirt, grit, sand, carbon, and other foreign matter endanger your bearings. N-B-M Silver Babbitt absorbs them.

It has that extra talent called "embedability" that keeps shafts and bearings from being scored.

The alloying of N-B-M Silver Babbitt permits abrasive matter to become embedded without impairing its compressive strength.

NATIONAL BEARING

DIVISION

ST. LOUIS • NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

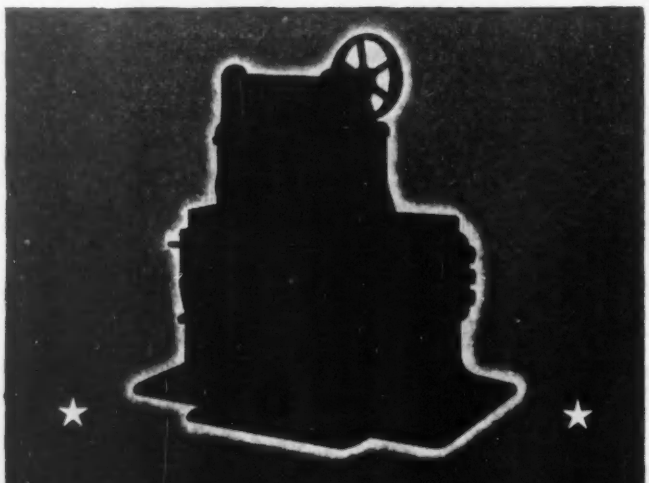
FENN SPECIAL MACHINERY

"No more production worries for him! He turns out the stuff faster than you can say 'Special Machinery' with new equipment built by FENN — and doing a better job, too."

Junk old machines that are eating their heads off every day. Get away from the idea of remodeling or rebuilding out-dated equipment. Start fresh with new, special machinery that is designed for faster, better, lower cost production.

FENN Special Machinery is custom-built to meet the individual needs of the user. Fenn experts have had years of experience in designing and perfecting not only the machines but the tools required to operate them.

When you put the Fenn organization to work building the modern machines demanded by today's production you are planning for profits. Why not get in touch with FENN?



THE FENN MANUFACTURING CO.
HARTFORD, CONNECTICUT
Special Machinery For Efficient Production

When Post-War Plans Call For SCREW MACHINE PRODUCTS . . .

TAKE IT TO *Federal Screw*

Here are two typical jobs produced at Federal Screw Works—an indication of the service available to you for the postwar manufacture of screw machine products of all types and sizes.

Aircraft Engine Cap: 1 1/4" hex SAE 6150 chrome-vanadium steel. External and large internal threads milled; small internal thread tapped—all Class 3 fit. All threads burred and all surfaces polished.

Aircraft Engine Rocker Arm Shaft: 11/16" round SAE 6150 bar stock, heat treated to 26-31 Rockwell C. Small diameters turned, thread rolled (Class 3 fit) and holes index-drilled at 90°. Diameters ground and polished to .0004" tolerance.

In addition to numerous batteries of modern automatics, the manufacturing facilities of our several large plants include milling, broaching, grinding, heat treating and electroplating departments. Cold-heading and thread-rolling departments are also at your service, as well as special secondary-operation equipment —*complete* production facilities unexcelled in the screw machine industry.

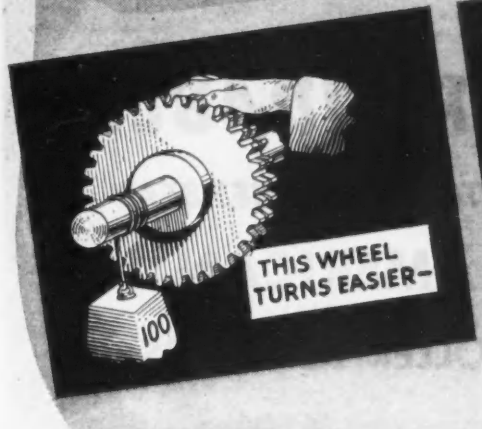
This variety and quantity of up-to-the-minute equipment, operated by skilled personnel and backed by long experience on widely-varied work, may well make Federal Screw Works the logical source of supply for many of your peacetime needs. Let's talk it over *now*; no obligation of course.

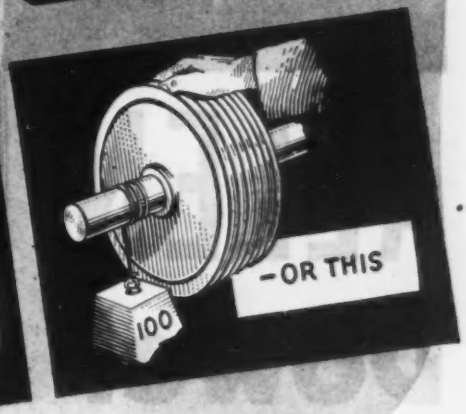
Navy "E" Burgee Awarded Jan. 31, '42
Army-Navy "E" Awarded July 29, '42
4 Stars Have Since Been Added to the Army-Navy "E" Flag

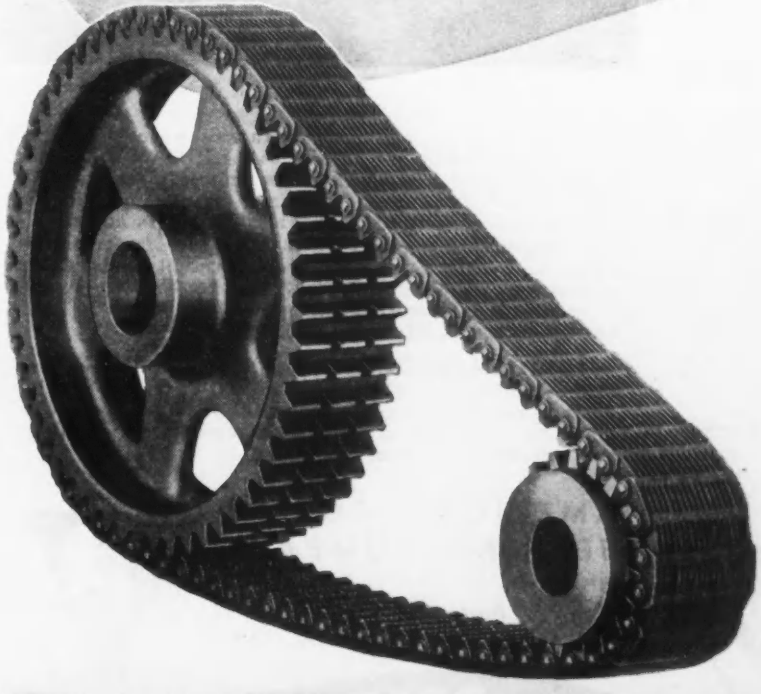
Federal SCREW WORKS
DETROIT AND CHELSEA, MICHIGAN
MAIN OFFICES: 3407 Martin Ave., Detroit 10, Michigan

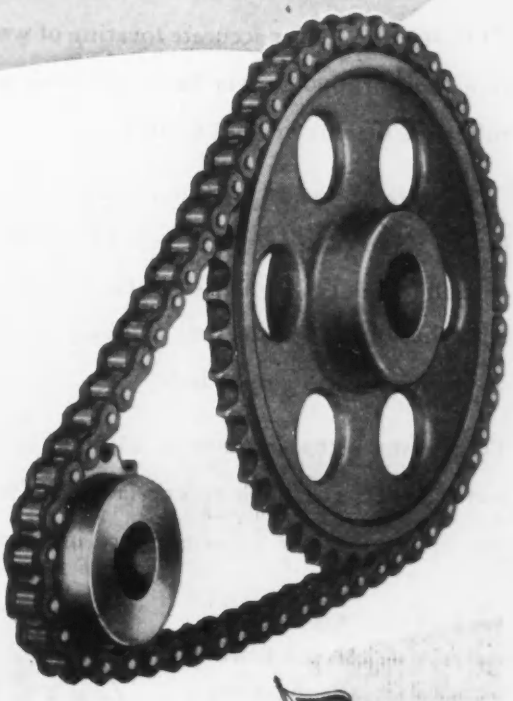
You can depend on

Teeth Not Tension









SPROCKETS CHAINS FLEXIBLE COUPLINGS CLUTCHES

MORSE Roller and Silent CHAINS

MORSE CHAIN COMPANY • ITHACA, N.Y. • DETROIT 8, MICH. • A BORG-WARNER INDUSTRY

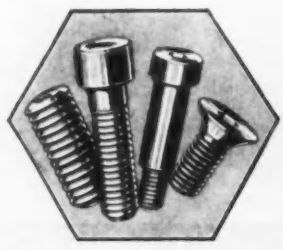
ALLEN Dowel Pins

"TRU-GROUND" for accurate locating of work: Ground to a limit of .0002" over basic size, with an allowable tolerance of plus or minus .0001".

"STEELED" to retain precision standards in die assemblies. Made of special-analysis ALLENOY steel, heat-treated to an extremely hard surface, with a core of the right hardness to resist any tendency to "mushroom" when driven into a tight hole.

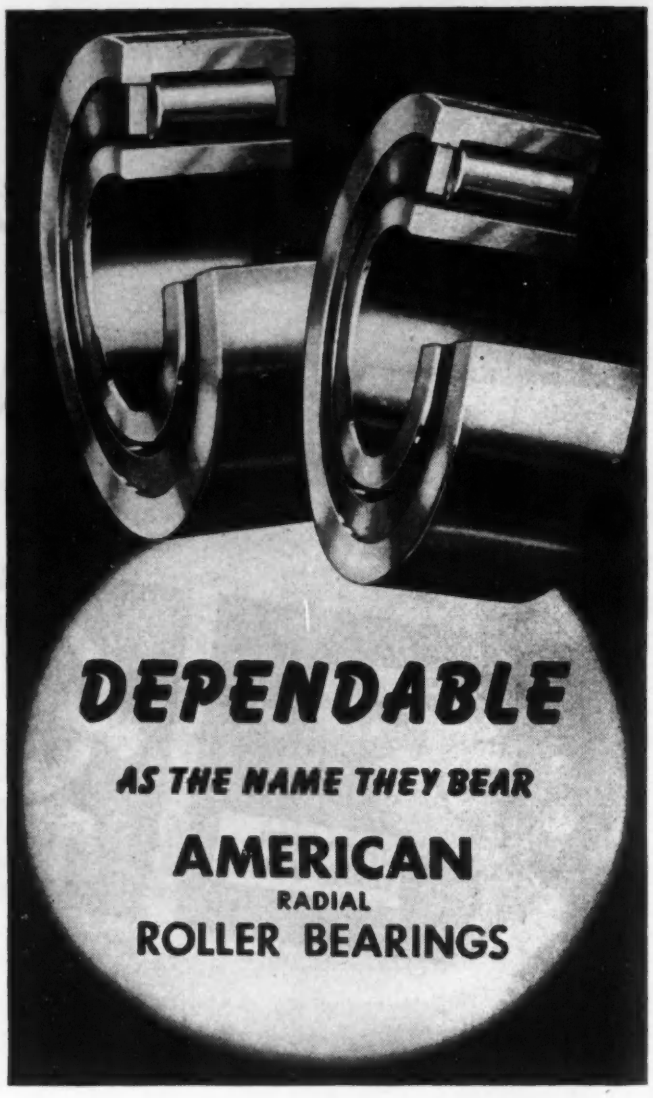
Tensile strength: 240,000 to 250,000 lbs. per square inch. Here's the high safety factor in *holding-power* you always get for plus-measure in Allen products.

Ask your local ALLEN Distributor for samples and dimensional data . . . the same Distributor who serves you dependably with Allen Hex Socket Screws and other "life-lines" of essential supplies.



TRADE A MARK

THE ALLEN MANUFACTURING COMPANY
HARTFORD 1, . . . CONNECTICUT, U. S. A.



DEPENDABLE

AS THE NAME THEY BEAR

AMERICAN RADIAL ROLLER BEARINGS

Engineered specifically for extra heavy duty applications where the load is *radial,* AMERICAN RADIAL ROLLER BEARINGS function smoothly and dependably under the most exacting service conditions. Specialized construction, flawless materials and precision manufacturing, set them apart as *the most dependable bearings yet designed* for radial loads where strains are greater . . . where toughness, super-strength and smooth, continuous, trouble-free performance are absolute requisites.

AMERICAN RADIAL ROLLER BEARINGS are made in 5 styles, 4 S.A.E. series and 85 sizes. Special designs to order are also available. Write for complete data or send us your requirements for analysis and recommendations.

AMERICAN ROLLER BEARING COMPANY
Pittsburgh Pennsylvania
Pacific Coast Office
1718 S. Flower St., Los Angeles, Calif.

AMERICAN HEAVY-DUTY ROLLER BEARINGS

and now the FLEX V TRADE-MARK

a New Fastener for A and B V-belts

Here is a new fastener, the Flex V, for the smaller sizes of V-belts that is going to establish the same outstanding performance record as the Alligator V-belt fastener has already established for the larger sizes of V-belts.

This new Flex V fastener is made in two sizes for A and B section V-belts. It is simple in design, easy to apply and the separable hinge joint makes for quick replacement of V-belts without dismantling shafting or machinery. No metal touches the pulley so Flex V fastened belts can be run on a V-Flat drive.

Folder No. V-12 gives complete details on this new Flex V fastener with list prices, special tools and application information. Your request will bring a copy.

Order from your supply house

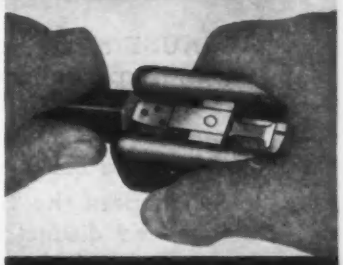
FLEXIBLE STEEL LACING CO.

4602 LEXINGTON STREET, CHICAGO 44, ILLINOIS

Also sole manufacturers of Alligator Steel Belt Lacing for flat transmission belts, Alligator V-Belt Fasteners for V-Belts and Flexco HD Belt Fasteners and Rip Plates for fastening and repairing conveyor belts.

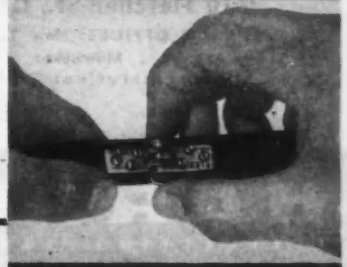
These illustrations show how easy it is to apply Flex V Fasteners

First a slit is cut in the end of the belt with the knife blade in the applicator.

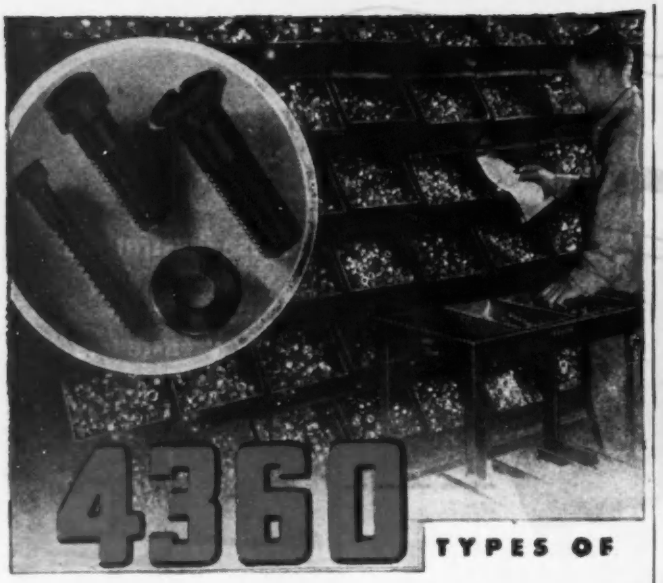


Then the lower part of the end plate is pushed into this opening in the belt.

The screws are inserted into the belt through the end plate.



The hinge pin is inserted to make the finished joint.



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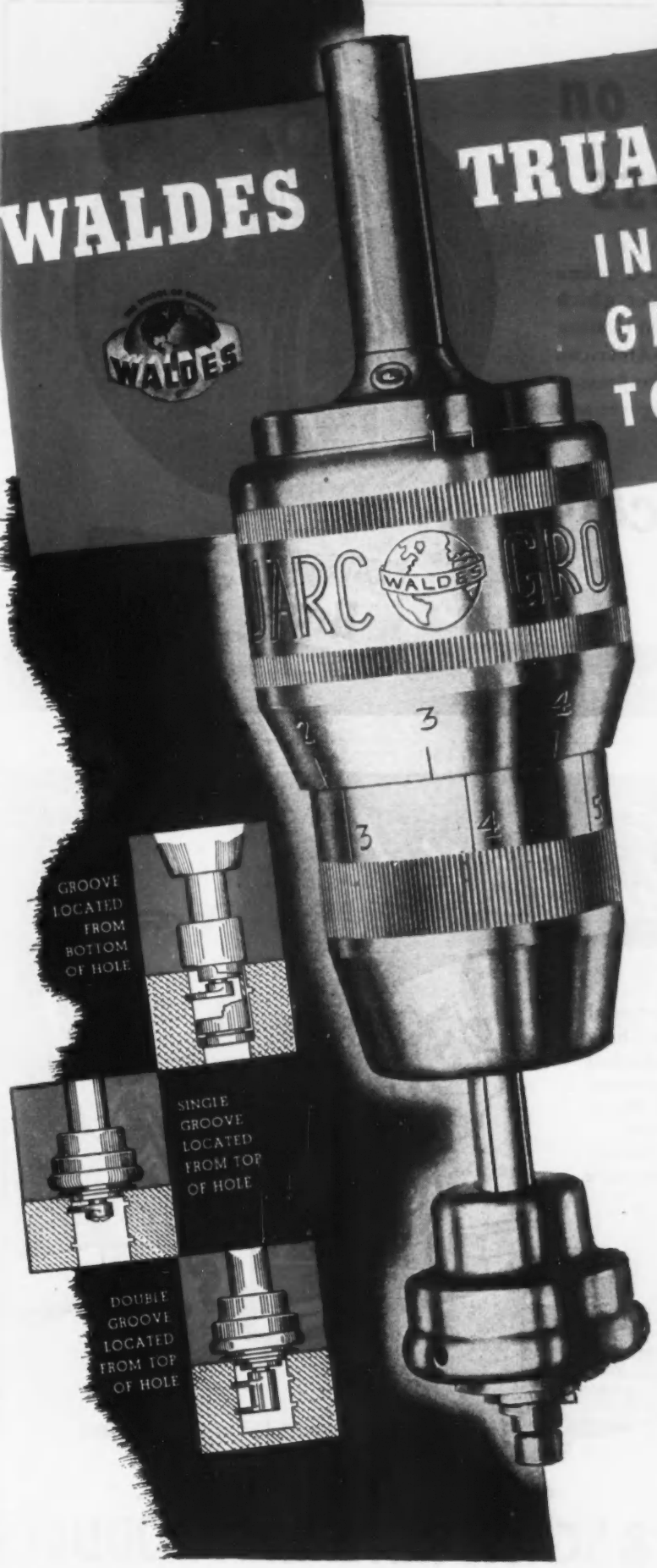

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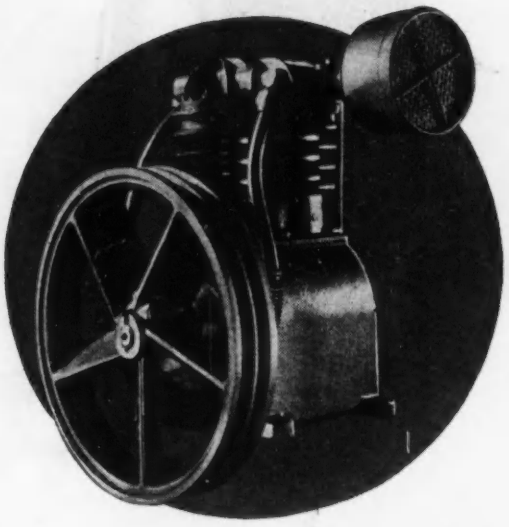

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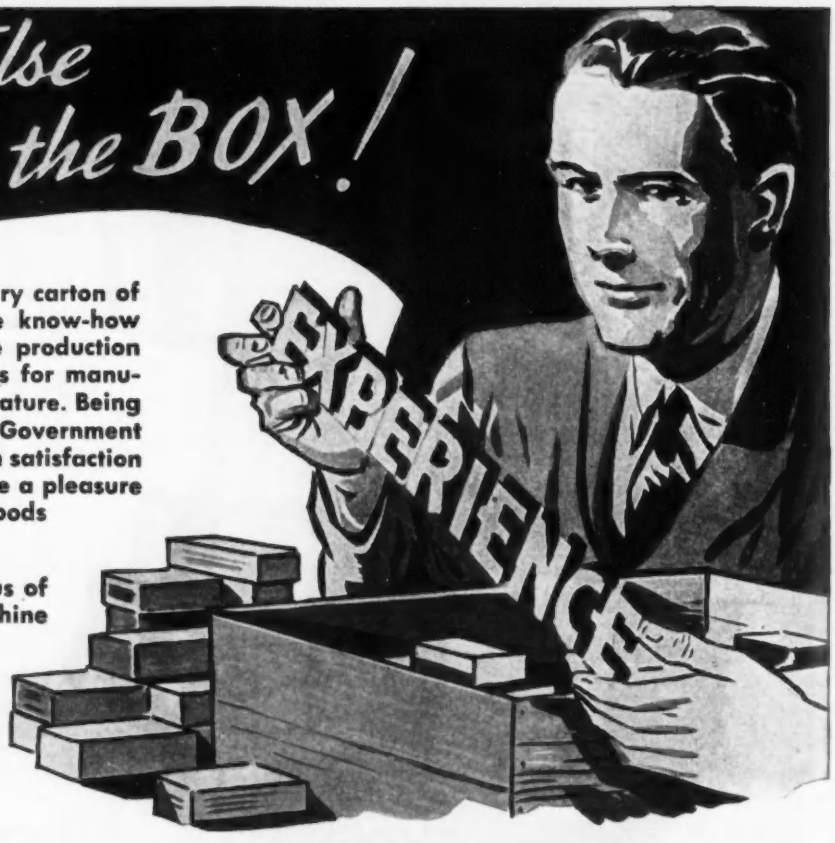

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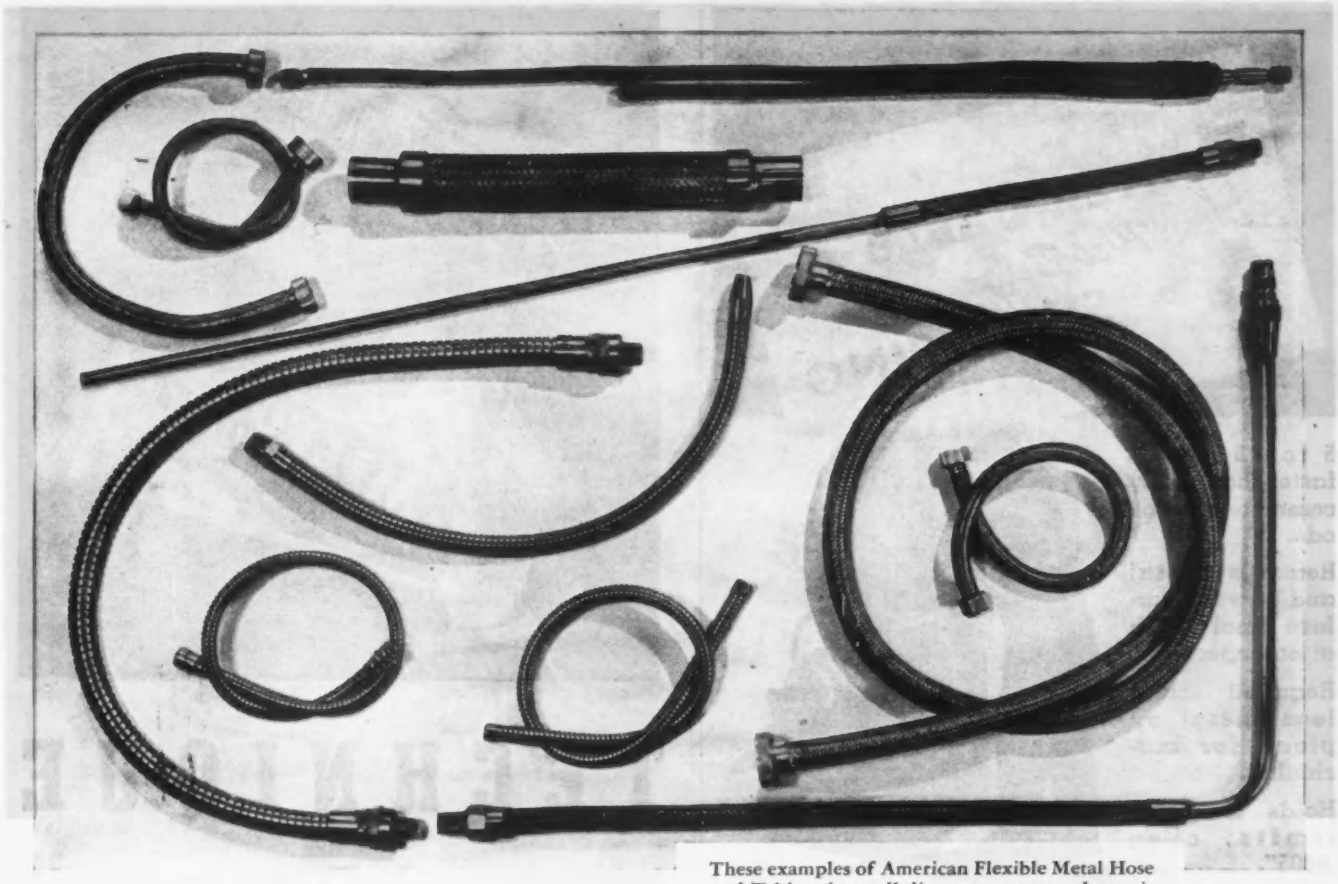

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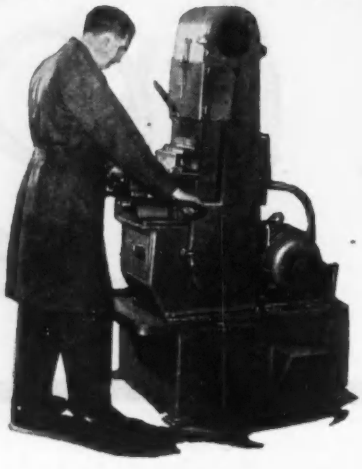

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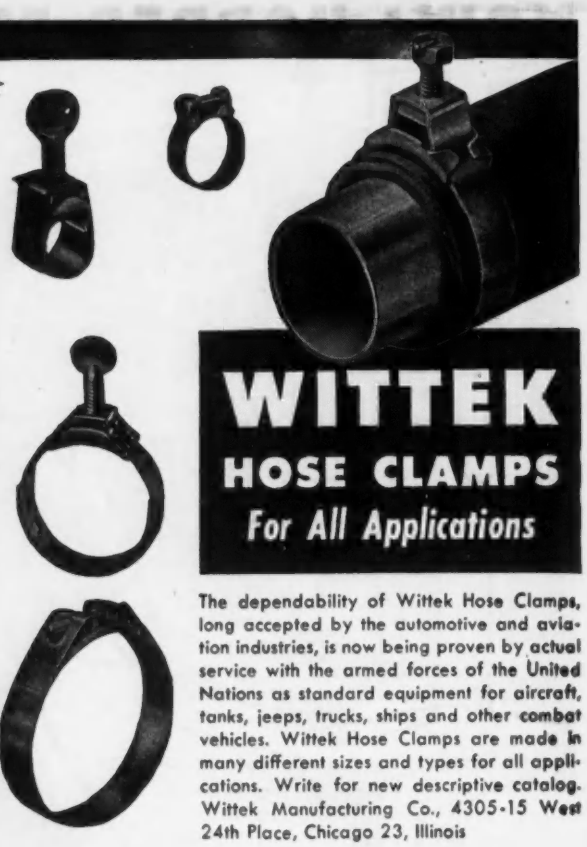

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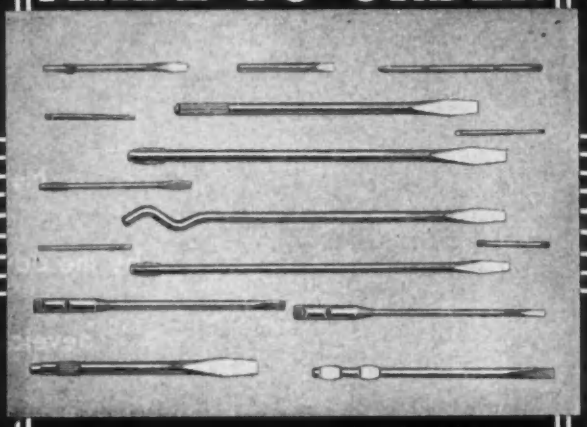

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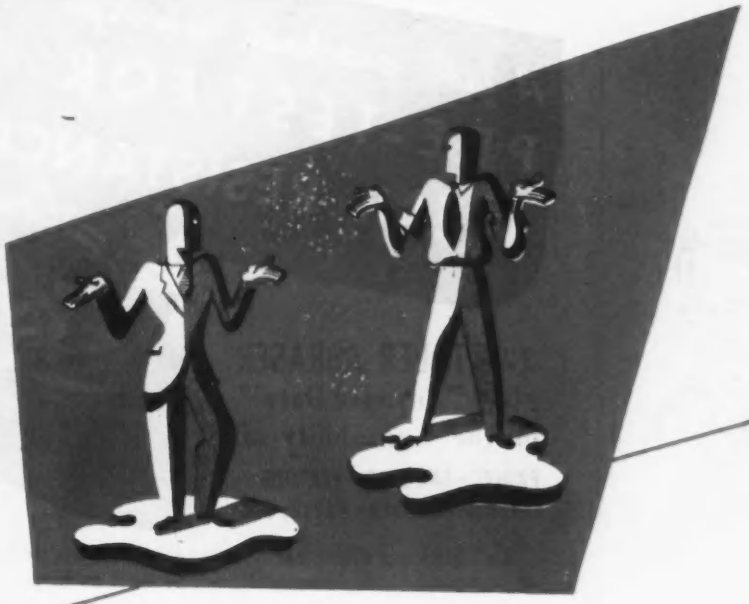

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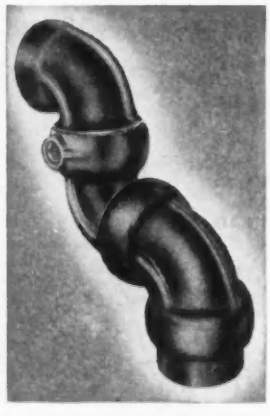

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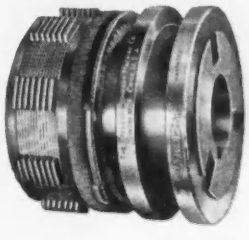

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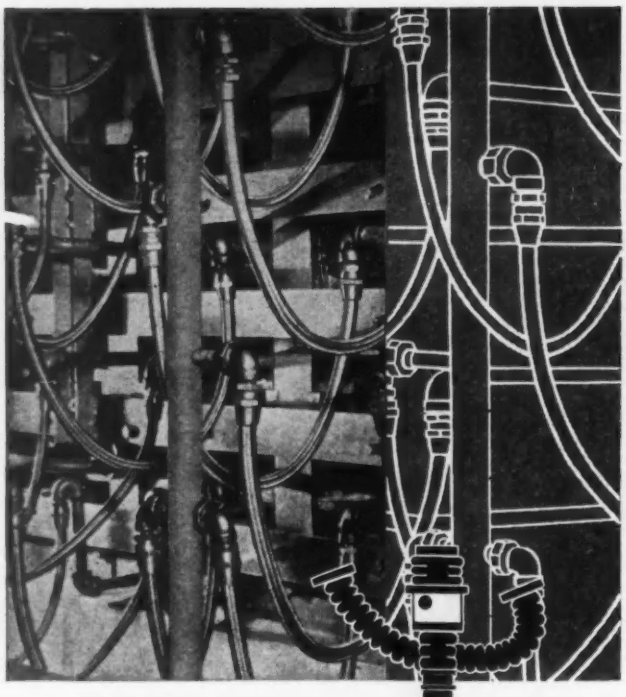

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Chicago Metal Hose Corporation engineers have had years of experience in helping designers and manufacturers meet all kinds of requirements. They will be glad to give you their recommendations in connection with flexible metal hose for your products of "tomorrow," or for the improvement of existing ones. Just write for literature, or for complete information about the Chicago Metal Hose engineering service.

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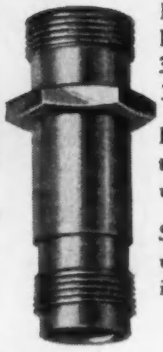

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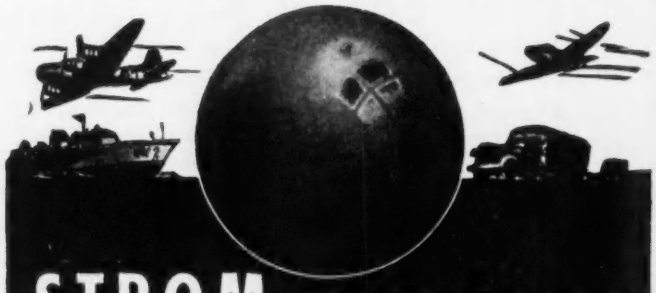

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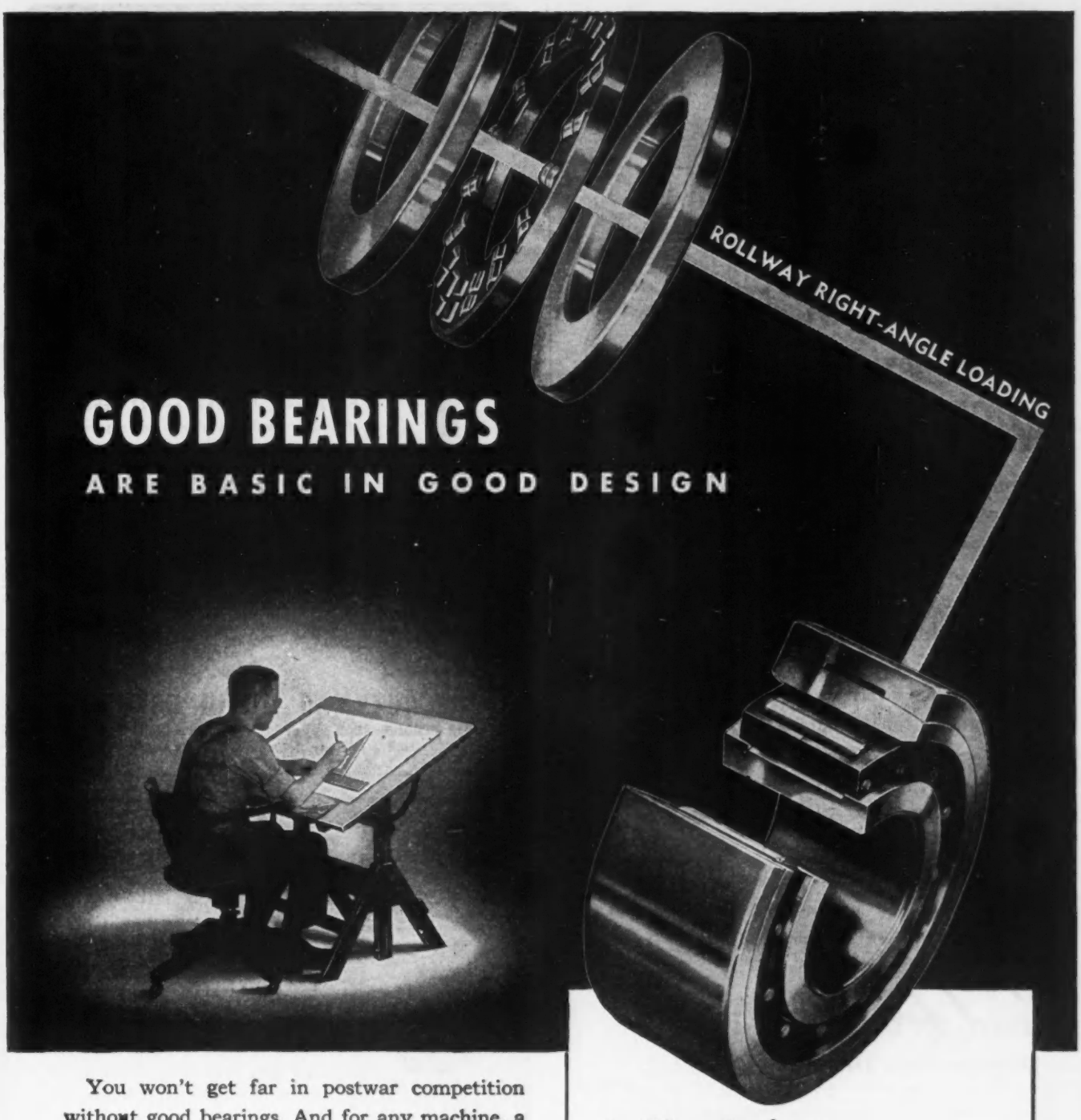


GOOD BEARINGS

ARE BASIC IN GOOD DESIGN

You won't get far in postwar competition without good bearings. And for any machine, a good bearing means simply that type which handles the load most efficiently and economically with the least maintenance cost and worry. That's where Rollway's Right-Angle Loading shines. It reduces load magnitudes and simplifies stresses. There's no piling of thrust loads on radial bearings or radial loads on thrust bearings. Shut-downs for bearing service and replacement are few and far between.

No Oblique Resultants . . .

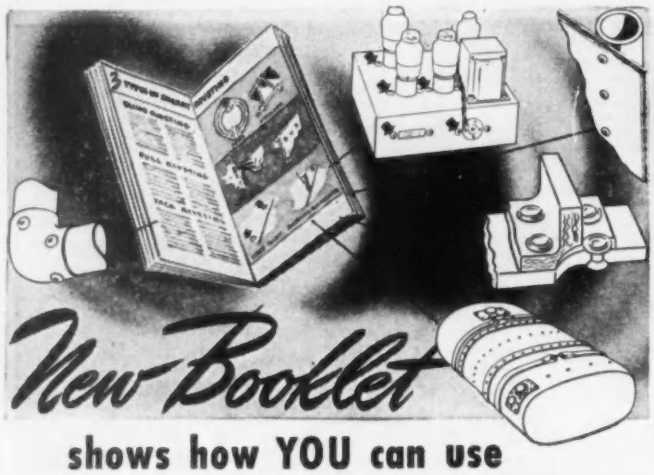
Rollway's Right-Angle Loading splits compound loads into their two components of pure radial and pure thrust. Each component is carried at right angles to the roller axis on separate bearing assemblies. No oblique loads and resultants, no thermal float or uncalculated thrust can impose secondary pressures on any Rollway Bearing. That means a bearing of given dimension will last longer, or carry heavier loads, or run at higher shaft speeds, or give any proportional combination of all three. Send us your drawings for free analysis. Without cost or obligation, we'll tell you how to get more service from your bearing dollars.

ROLLWAY BEARING COMPANY, INC.
Syracuse 2, N. Y.

since 1908 makers of

ROLLWAY CYLINDRICAL ROLLER BEARINGS

SALES OFFICES: Philadelphia • Boston • Pittsburgh • Youngstown • Cleveland • Detroit • Chicago • St. Paul • Houston • Tulsa • Los Angeles



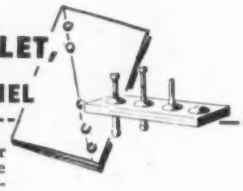
New Booklet

shows how YOU can use CHERRY BLIND RIVETS

This new three-color sixteen-page booklet—filled with application pictures and drawings—shows at a glance the outstanding features of Cherry Blind Rivets and suggests a large number of interesting new rivet uses, many of which may be applicable to your particular fastening and riveting problems. Send for it now!

Cherry Blind Rivets solve satisfactorily the time-worn problem of riveting in blind and hard-to-get-at spots. They are upset with a "pull" instead of a pound—from one side of the job by one man alone—their positive mechanical action assures satisfactory installations—they have proven their worth in many installations that are not necessarily blind—head up in metals, plastics, rubber, plywood, leather, fabrics, enameled surfaces.

Send for BOOKLET, DEMONSTRATION PANEL



I would like to glance through your new booklet D45. Please also send me the metal demonstration panel showing the stages in heading an actual Cherry Rivet.

Cherry Rivet Company, Los Angeles 13, California – Dept. A-106

Name_____

Address_____

City_____ Zone____ State_____

Firm_____ Title_____

CHERRY RIVETS, THEIR MANUFACTURE & APPLICATION ARE COVERED BY U.S. PATENTS ISSUED & PENDING

Cherry Rivet Company

LOS ANGELES, CALIFORNIA

ONE-PIECE SHAFT *no couplings*

Model HL-15025-B

FOR VIBRATIONLESS R-I-G-I-D-I-T-Y

The heavy one-piece shaft used in ALL models is ground all over and the entire rotating assembly is electronically balanced. This gives perfect alignment, vibrationless rigidity and trouble-free operation. This new Model HL-15025-B Deep Immersion is furnished in two lengths, 19 inches and 23 inches below the high level line of coolant reservoir and like all other

GUSHER COOLANT PUMPS

it has no packing glands nor metal-to-metal contacts below the high level line. Less friction, less wear, longer life.

Types and models for all your needs.

THE RUTHMAN MACHINERY CO.

1813 READING ROAD CINCINNATI 2 OHIO

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Smartly styled, expertly made name and data plates by Robbins bring positive identification, enhanced appearance and an extra advertising plus to any product. Manufacturers of heavy equipment and luxury utilities alike know the multiple advantages obtained from using Robbins Quality Name Plates . . . metal, plastic or metal with enamel.

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Manufacturers of Emblems and Plaques for over Fifty Years

To learn how a name plate can help your product, send for your copy of "Name Plates by Robbins".

What are "A-Q"* Gears?

"A-Q"* is a symbol for aircraft quality. Gears so designated represent a new development in power transmission. They must have extremely light sections and carry loads far in excess of values customarily considered safe design. They must operate at pitch line velocities that can be measured in miles per minute.

How Are Such Gears Produced?

Producing "A-Q"* gears demands control of material at every stage of production from billet to finished blank. It demands extraordinary care in heat treatment so that each gear is of the proper hardness at the tooth and at the core. It means holding every dimension to close tolerances and watching tolerances to prevent excessive multiplied error.

To achieve the extreme accuracy demanded in "A-Q"* gear production, Foote Bros. have developed new manufacturing techniques—revolutionary equipment.

Why Were They Developed?

The insistent demand of war for aircraft engines of tremendous horsepower produced by the thousands proved a serious problem in the development of gears for these engines. Engine manufacturers required gears closely approximating engineering perfection—and, furthermore, demanded that these gears be produced by the hundreds of thousands. By applying the "know-how" acquired in three-quarters of a century of gear manufacture, Foote Bros. met the need for these new gears.

How Can They Be Applied to Peacetime Products?

"A-Q"* gears offer many distinct advantages to the manufacturer of tomorrow's peacetime machines. They assure greater mechanical efficiency—a reduction in weight—greater speed—less noise—greater compactness—and a more economical transmission of power.

FOOTE BROS. GEAR AND MACHINE CORPORATION
Department W, 5225 S. Western Blvd. • Chicago 9, Illinois

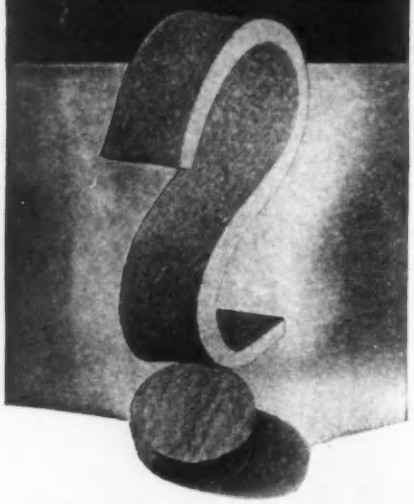
"A-Q" Stands for Aircraft Quality

This informative product engineering manual on "A-Q" gears contains data on a new and revolutionary type of precision gear. A copy will be sent to you on request as soon as it is ready.

FOOTE BROS.

Better Power Transmission Through Better Gears

How strong CAN felt BE MADE



TENSILE breaking strength as great as 1016 pounds per 2-inch width was observed during laboratory tests of 2″ x 10″ strips (0.375″ to 0.5″ thick) of six different Booth felt types.

Almost any desired combination of qualities ... durability is only one ... are obtainable through the *controlled* manufacture of Booth "prescription" felts and precision die-cutting into mechanical parts. Read Booth's "Technique of Felt Making."

THE BOOTH FELT COMPANY

475 19th Street . Brooklyn, N. Y.
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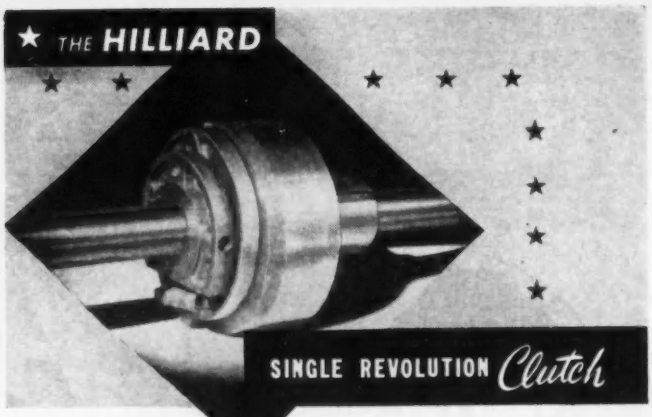
APPLICATION CHART AND SAMPLE KIT . . . Contains swatches of S.A.E. felt types, with specification tables. Write for it. (No sales follow-up.)

2075

Booth
TRADE MARK

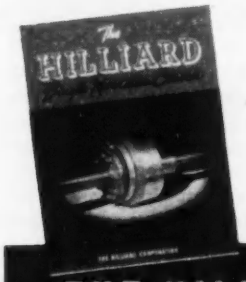
PRECISION CUT FELT PARTS

★ THE HILLIARD



SINGLE REVOLUTION *Clutch*

Wherever extremely accurate control of intermittent machine operation is essential the Hilliard Single Revolution Clutch is unequalled. Its accuracy has won for it the acceptance of Industry for cutting, punching and packaging operations.



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For the new series of 6 illustrated Bulletins furnished FREE upon request. Featuring our complete line of Industrial Clutches and Couplings – Over-Running – Single Revolution – Friction – Centrifugal – Overload Release – Slip.

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If your new or improved products will benefit from better clutches, we can give you timely help:

As clutch building specialists with over a quarter century of experience, we study your product designs and recommend the BEST clutches for your particular needs. We then have the facilities to produce those clutches on a basis that will strengthen the competitive position of your products — as to power, control, size, weight, service and price. BRING YOUR CLUTCH PROBLEMS TO US — By sending your specifications to us NOW, your clutch needs can be met without unnecessary delay — when reconversion starts.

SEND FOR THIS HANDY BULLETIN ON POWER TRANSMISSION
It shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacitity tables, dimensions and complete specifications. Every production engineer will find help in this handy bulletin, when planning postwar products.

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Borg-Warner Corporation
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Housing the unusual is usual procedure at

DAHLSTROM

Being specialists, Dahlstrom engineers are experienced in solving a wide variety of product housing and metal fabricating problems. The one illustrated below . . . a combination desk and housing for R. C. A. Victor's famous Electron Microscope . . . did, however, call upon all of Dahlstrom's 40 years' experience and metal sense. You can gain time on your post-war planning by putting your metal fabricating or product housing problems up to Dahlstrom *now*. While we too are busy with the war, our engineering and designing staffs do have time to contribute. Write today.

Dahlstrom Metallic Door Company, Jamestown, N. Y.

ELECTRONIC MICROSCOPE DESK

This desk is an example of a specialized product housing developed by Dahlstrom to contain highly technical equipment. It meant careful collaboration with our client's engineers to translate efficiently their needs into metal fabrication. It combines modern design with functional requirements plus construction that can be manufactured economically. Write for your copy of "Metal Moldings and Shapes."

Made of 18, 16, and 14 gauge steel. The size of the cabinet is 48" long by 29" deep; desk height is 30¼"; overall height is 42½". Cabinet is finished with one coat of primer and two coats of synthetic enamel in three shades of cobalt gray. Photo R. C. A. Victor.

ARMY E NAVY

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Designing, Engineering and Fabricating of Special Cabinets . . Racks Mouldings . . Control Desks and Panels . . Radio Chassis . . Stampings Enclosures . . Pressed Shapes . . Product Cases . . Special Parts

THE NEW *Geneva-loc Actuator*

NO CLUTCHES
NO LIMIT SWITCH ADJUSTMENT
MOTOR STARTS AT NO LOAD
POSITIVE POSITIONING OF SHAFT INDEPENDENT OF MOTOR OVERTRAVEL
NO CAPACITOR OR BRAKE REQUIRED

AS THE NAME IMPLIES, these new Actuators by Pacific Division exclusively incorporate a Geneva movement operated by a high speed motor. Positioning by switches has been completely eliminated.

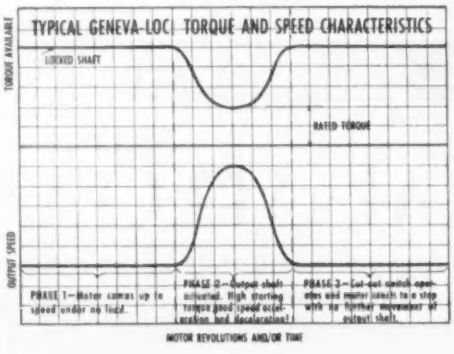
These Actuators offer extremely accurate control (within 1°) of any series of operations up to eight positions with each position positively locked against movement.

There are no clutches, torque limiters, brakes or adjustable limit switches—eliminating major causes of trouble.

Motor comes up to speed under no load, then engages cam with varying ratio which develops maximum torque at breakaway positions. Thus cutout switches always operate when motor is under no load, permitting maximum switch life.

Write or wire today for the complete story on these simplified, positive actuators. Pacific Division, Bendix Aviation Corporation, 11600 Sherman Way, North Hollywood, Calif. Sales Engineering offices in New York City and St. Louis.

Pacific Division — Bendix Aviation Corporation


TYPICAL GENEVA-LOC TORQUE AND SPEED CHARACTERISTICS
LOCKED SHAFT
RATED TORQUE
TORQUE AVAILABLE
OUTPUT SPEED
PHASE 1—Motor comes up to speed under no load.
PHASE 2—Output shaft actuated. High starting torque good speed acceleration and deceleration.
PHASE 3—Cut-out switch operates and motor coasts to a stop with no further movement of output shaft.
MOTOR REVOLUTIONS AND/OR TIME

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REG. U.S. PAT. OFF.

Added Values . . .

Plus Protection!

Glass Constant Level

TRICO OILERS provide your bearings with positive lubrication. You and your customers get all these added values and protection . . .

- Visible oil supply
- No down-time for hand-oiling
- Added machine life
- Less maintenance and repair
- Maximum production
- Streamlined appearance
- Greater sales appeal
- Customer satisfaction
- Increased prestige
- Less fire and accident hazards

Plastic Constant Level

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Insure dependable lubrication of your equipment after it leaves your plant and safeguard your customers' costly investment . . .

Gravity

Loose Pulley

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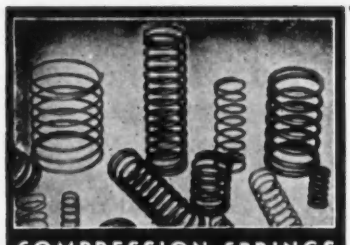
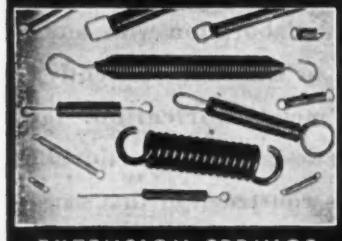


COMPRESSION SPRINGS



EXTENSION SPRINGS

TORSION SPRINGS

if

It's Made From ROUND OR FLAT WIRE

Cuyahoga Spring Co. can make it, including welded, pointed or threaded parts in any metal or finish. Send for descriptive folder.

SNAP CLIPS

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Have Already Been Sent Out on Request. There Is a Copy For Your Ready Reference File. It is FREE!

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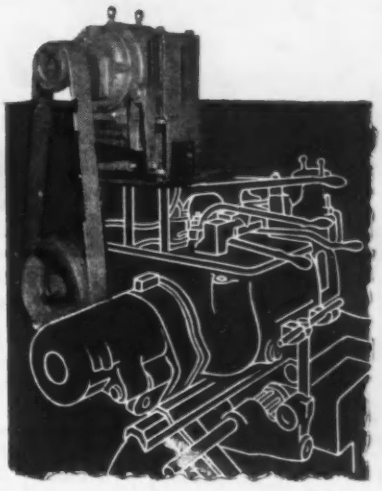
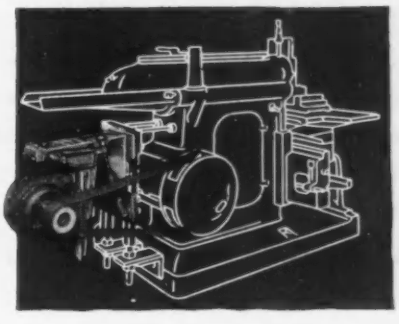
There are thousands of Engineers, Plant Maintenance and Repair Men who should have the benefit of all the information contained in the ALBA Short Center DRIVE DATA BOOK. With it you can quickly and accurately determine the proper width and thickness of belt to be used. It also contains information covering belt speeds; correction factors for center distances, atmospheric conditions, pulley materials, angle of center line, service and peak loads. Proper flat Leather Belt drives can be easily selected from this Book to meet practically any operating condition. Send today for your FREE copy. Just write to —



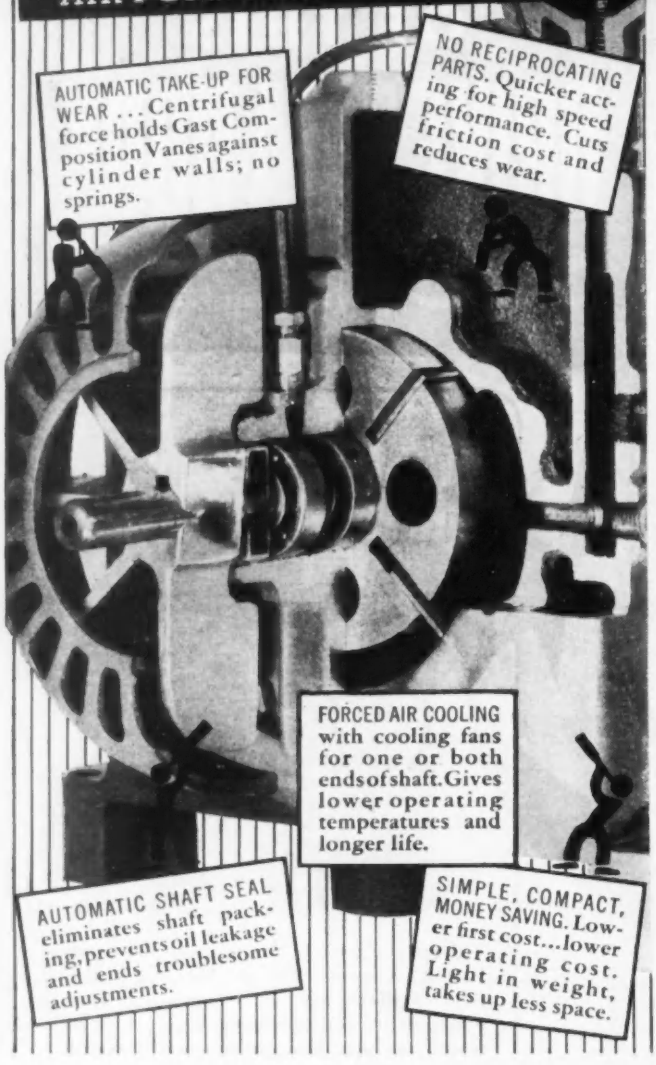
Here you see how adaptable the flat Leather Belt short center drive can be, on a machine tool. Will fit almost any space, vertically, horizontally, or at any angle. Automatic belt tension reduces maintenance and minimizes wear on motor and machine bearings.



Even unusual drive designs can be met. For instance, this shaper as shown, with vertical drive, driving horizontally, handles perfectly with flat Leather Belt and pivoted motor base.

AMERICAN LEATHER BELTING ASSOCIATION · 41 Park Row, NEW YORK 7, N. Y.

LOOK INTO GAST ROTARY AIR PUMPS and COMPRESSORS


AUTOMATIC TAKE-UP FOR WEAR . . . Centrifugal force holds Gast Composition Vanes against cylinder walls; no springs.
NO RECIPROCATING PARTS. Quicker acting for high speed performance. Cuts friction cost and reduces wear.
FORCED AIR COOLING with cooling fans for one or both ends of shaft. Gives lower operating temperatures and longer life.
AUTOMATIC SHAFT SEAL eliminates shaft packing, prevents oil leakage and ends troublesome adjustments.
SIMPLE, COMPACT, MONEY SAVING. Lower first cost...lower operating cost. Light in weight, takes up less space.

"Look into" Gast Rotaries . . . Examine the advantages they offer. You'll be convinced that Gast Rotary Air (or Vacuum) Pumps and Compressors give unequalled efficiency and trouble-free performance. It will pay you to investigate the Gast Rotary Design for any application where vacuum or compressed air is used, or *could* be used.

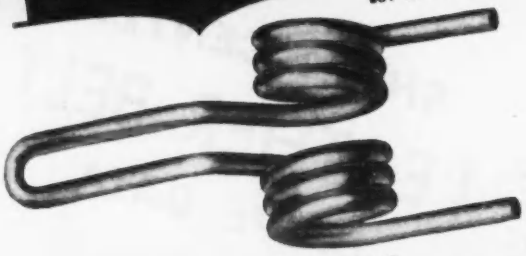
Write today for your **Free** Copy of the Gast Catalog

GAST MFG. CORP., 107 HINKLEY STREET
BENTON HARBOR MICHIGAN

ROTARY
GAST AIR
MOTORS • COMPRESSORS
VACUUM PUMPS

Springs OF ALL KINDS

BUY WAR BONDS



TORSION SPRINGS • Both single and double, are carefully controlled through each stage of manufacture by experienced spring specialists assuring a uniformity of perfection. California Spring Co.'s knowledge and complete equipment are available in the solution of your war or post-war spring problems.

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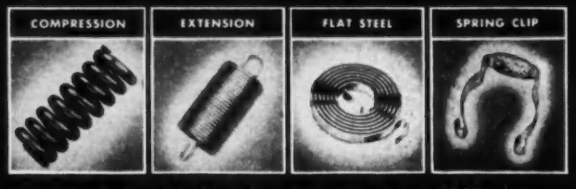

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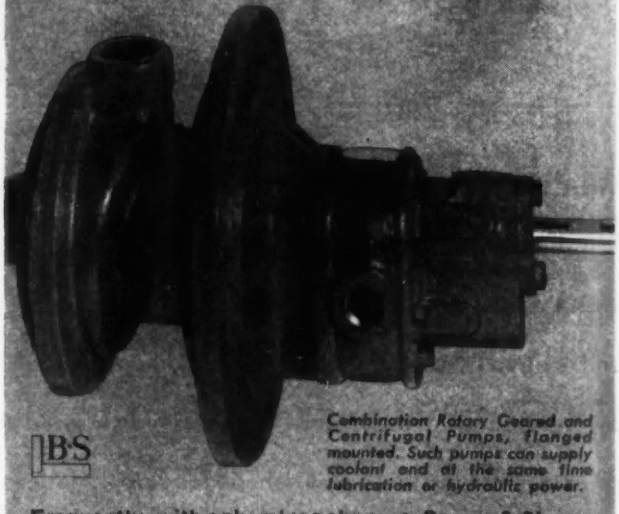


Combination Rotary Geared and Centrifugal Pumps, flanged mounted. Such pumps can supply coolant and at the same time lubrication or hydraulic power.

Frequently, with only minor changes, Brown & Sharpe Stock Pumps can be adapted for special installations or combinations, simplifying problems of coolant supply, lubrication, transfer or hydraulic operation. Complete Pump Catalog sent on request. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

GEARED — VANE — CENTRIFUGAL — MOTOR DRIVEN

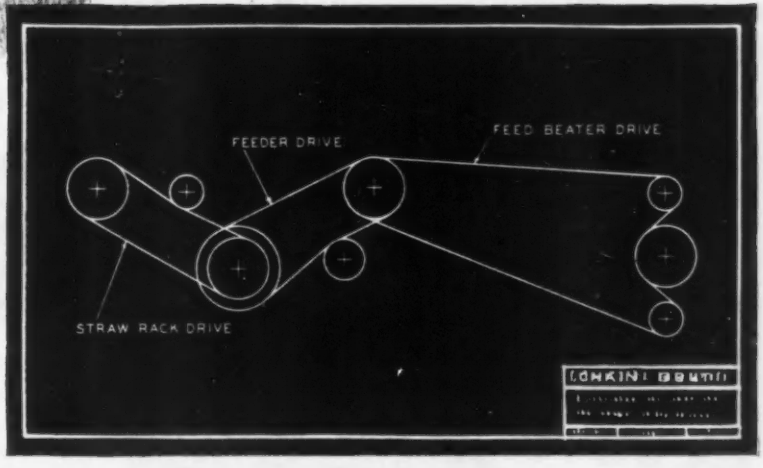
BROWN & SHARPE PUMPS

"THEY FOUND THE *Right Combination* FOR A COMBINE"

❶ STRENGTH, ACCURACY—these are the two basic requirements for a combine-drive. Strength to stand up under heavy loads and resist the dust, heat, rain and mud of farm service . . . accuracy to properly time and co-ordinate the various intricate functions of the combine. Machine designers found the right combination for both in one drive . . . Baldwin-Rex Roller chain belts.

❷ THERE'S NO SLIPPING, no wasted power . . . with Baldwin-Rex on the job. Every mechanical operation of the combine is accurately timed to mesh perfectly with each successive step. Shocks of traveling over rough ground are not passed on to the transmission or other machine parts for these chain belts are highly shock absorbent. Baldwin-Rex is a positive drive that's positively right for all types of power transmission, timing and conveying functions.

❸ HERE'S WHERE THEY WORK. This drive design arrangement of the combine shows how Baldwin-Rex transmits power from the engine, drives the straw rack, the feeder, the feed beater, the shaker and fan. The smooth, quiet operation, simplicity of installation and adjustment, compactness and low maintenance of these chains make them the most efficient means of transmitting power and timing operations.

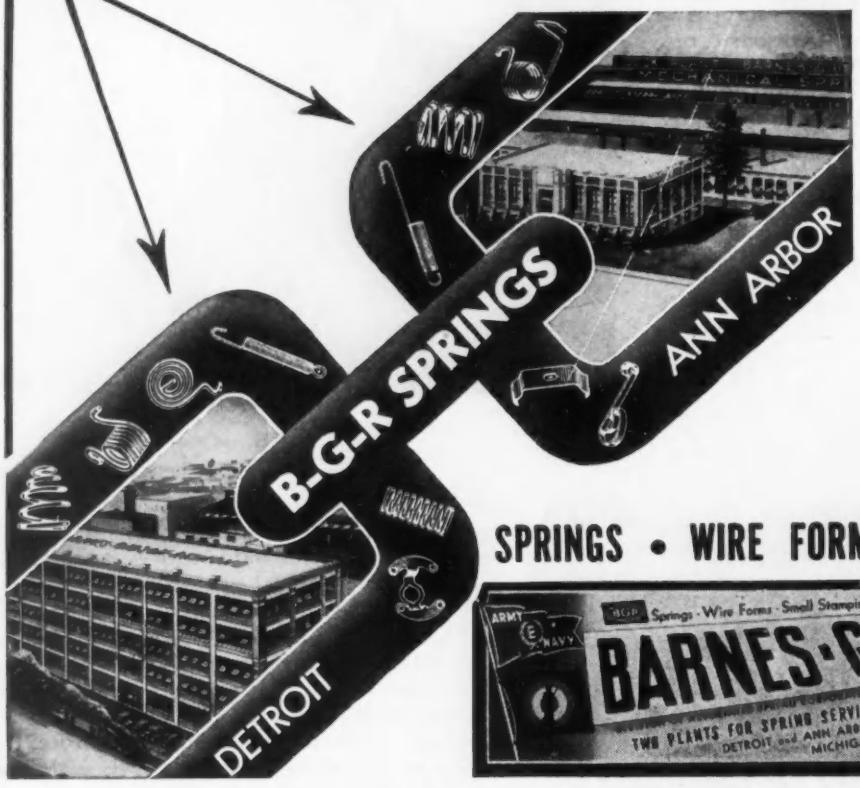


For catalogs on Baldwin-Rex Roller chain belts or competent information on your specific drive problems, write to **BALDWIN-DUCKWORTH** *Division of* **CHAIN BELT COMPANY,** *321 Plainfield Street, Springfield 2, Mass.*

BALDWIN-REX *ROLLER CHAIN BELTS*

Baldwin-Duckworth Division, Springfield 2, Massachusetts • Rex Chain Belt and Transmission Division, Rex Conveyor and Process Equipment Division, Milwaukee 4, Wisconsin

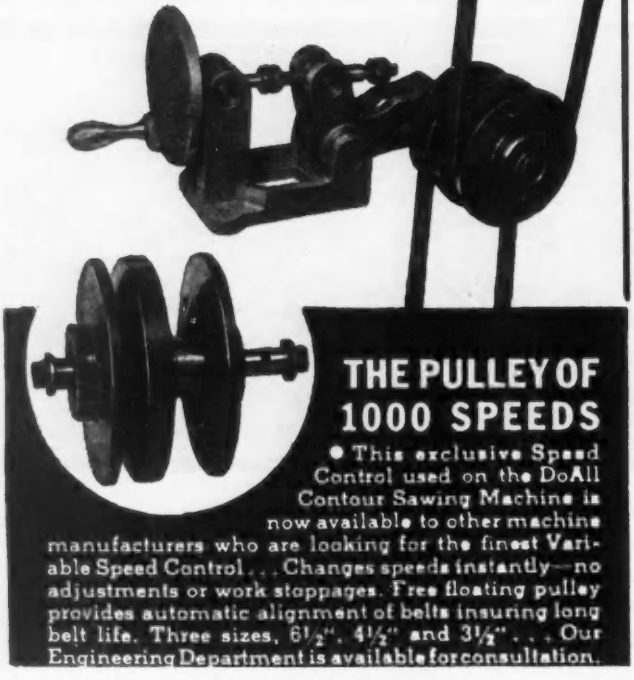
2 PLANTS -- LINKED FOR SERVICE



Forged securely together by identical standards of quality and production, both B-G-R Spring Plants act as one to give you unlimited service in springs of all kinds—in any quantity. When you buy springs—get the benefits of B-G-R research and engineering design—for long life and trouble-free performance.

SPRINGS • WIRE FORMS • SMALL STAMPINGS

SPEEDMASTER



THE PULLEY OF 1000 SPEEDS

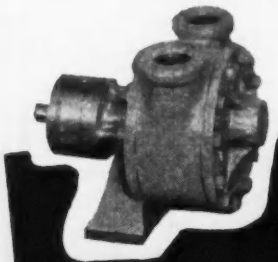
• This exclusive Speed Control used on the DoAll Contour Sawing Machine is now available to other machine manufacturers who are looking for the finest Variable Speed Control . . . Changes speeds instantly—no adjustments or work stoppages. Free floating pulley provides automatic alignment of belts insuring long belt life. Three sizes, 6½", 4½" and 3½" . . . Our Engineering Department is available for consultation.

Write for Literature

THE DOALL COMPANY

1213 THACKER ST. DES PLAINES, ILL.

WHEN YOU NEED PRECISION-BUILT SMALL PUMPS . . . *Specify* TUTHILL



FOR HYDRAULIC MECHANISMS . . . IT'S MODEL CK

For dependable, economical service on hydraulic mechanisms, machine tools and engines, Tuthill offers the compact Model CK internal-gear rotary pump. Designed to save space, material and money. Sizes range from 1 to 50 g.p.m. at pressures up to 400 p.s.i. Direct motor drives, V-belt units and integral drives. Write for Model CK bulletin.

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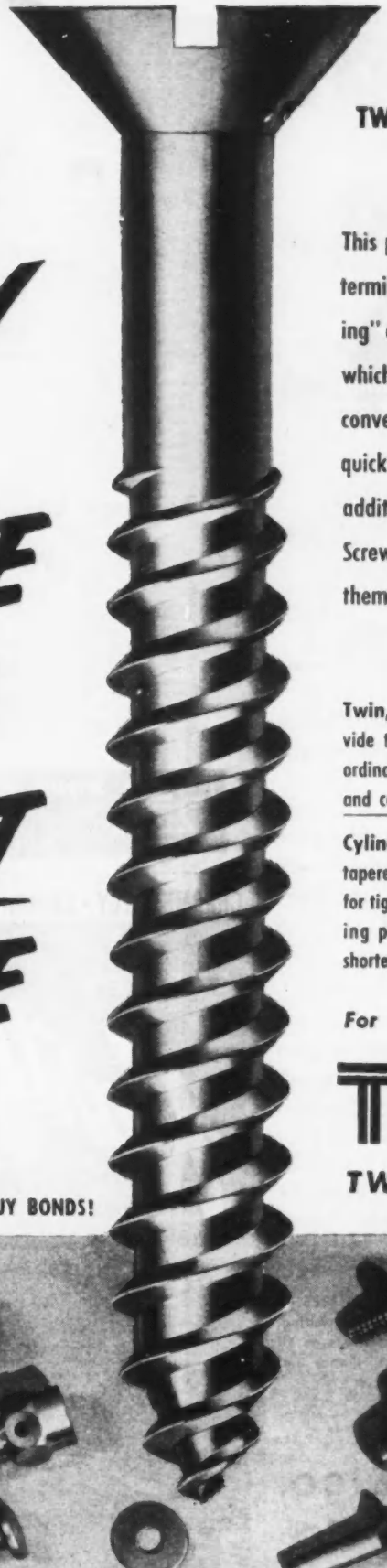
Tuthill Pumps are serving Army • Navy Air Force • Merchant Marine and Industry

TUTHILL PUMP COMPANY

939 East 95th Street • Chicago 19, Illinois

IT'S EASY TO DRIVE THIS POINT HOME



TWIN-FAST's point is hard, sharp, centered, for quick "bite"—fast driving

This point is formed by Twin-Fast's parallel twin threads terminating at the axial center of the screw. No "crawling" and little likelihood of misalignment or displacement, which may be caused by the off-center (gimlet point) of conventional type screws! ● The Twin-Fast point assures quick starting, self-centering, balanced driving. That means additional savings in time, labor, materials. Yet Twin-Fast Screws cost no more than ordinary wood screws! ● Test them yourself in your own plant. Just write for samples.

Other Twin-Fast Features

Twin, parallel threads provide twice the thread pitch of ordinary screws. Driving time and costs are cut in half!

Cylindrical construction (not tapered) increases thread area for tighter seating, greater holding power. Often, fewer and shorter screws may be used.

Relieved shank diameter prevents stresses which might cause immediate or eventual splitting or fissures.

Twin-Fast Screws come in steel or brass with round, flat or oval heads—standard sizes and thread count.

BY ALL MEANS—BUY BONDS!

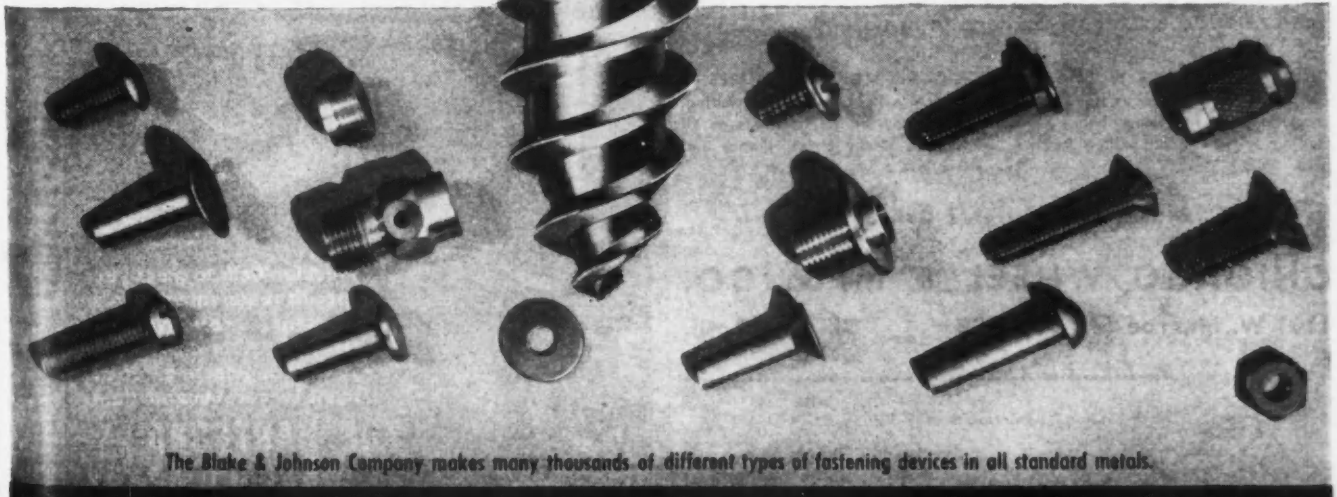
For Faster Production—Sounder Construction—

TWIN fast

Reg. U. S. Pat. Off.

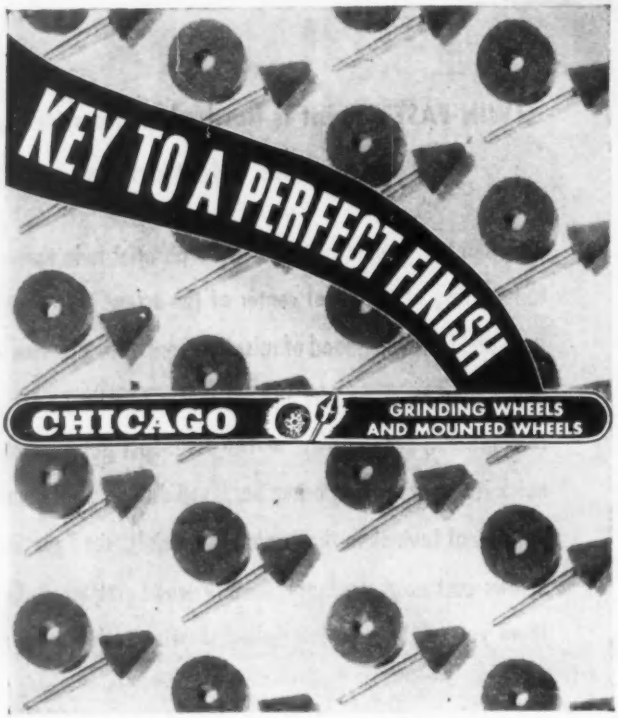
TWIN THREAD WOOD SCREWS

Patents 2,314,390; 2,314,391. Other pats. pending.



The Blake & Johnson Company makes many thousands of different types of fastening devices in all standard metals.

THE BLAKE & JOHNSON COMPANY (Since 1849) WATERVILLE, CONNECTICUT



Chicago Wheel takes pride in providing you with exactly the wheel you need, for exactly the job you have, to give you exactly the finish you want!

There's half a century of experience behind this, fifty years of specializing on grinding wheels—grinding wheels with hundreds of varieties in shape, size, abrasive and bond formulas, engineered for the right tool speed and work pressure.

COME TO HEADQUARTERS

Our long experience and testing laboratory are at your service, free for the asking. Tell us about your tough grinding or polishing job. Our abrasive engineers will report promptly, give you their tested solution.

TRY ONE FREE—A Chicago Mounted Wheel or an FV Bond Grinding Wheel sent promptly on request. Tell us size preferred and what you have to grind.

CHICAGO GRINDING WHEELS — For the duration, sizes up to 3" in diameter only, in various bonds including FV, the bond with a pedigree.

CHICAGO MOUNTED WHEELS — For internal or external grinding, burring and polishing. Made to fit any tool. Many styles, shapes and shank sizes.

Send for Illustrated Catalog

CHICAGO WHEEL & MFG. CO.

1101 W. Monroe St., Dept. PE **Chicago 7, Ill.**

Send catalog. Interested in

☐ Mounted Wheels ☐ Grinding Wheels

☐ Send test wheel Size.....

Name .....

Address .....

THIS ONE WEIGHS 450 LBS.
This big POPE Spindle is a live center tailstock for a production engine lathe. The Spindle is 53" long, 6⅛" in diameter. Its center is easily removable without disturbing the bearings. The shaft in which the center is mounted is carried on preloaded roller bearings capable of supporting work pieces weighing 10 tons.

The thrust bearings are preloaded to 7000 lbs. initial end pressure and are yieldingly mounted for axial movement. This provides automatic compensation for the expansion of the work piece from the heat of the cutting tool.

THIS ONE WEIGHS 1½ LBS.
This "ladyfinger" size spindle is an example of the small spindles built by POPE. It is 6¼" long, 1¼" in diameter. It operates at 40,000 RPM in a small profile grinder.

These large and small spindles are illustrated to show that POPE Precision Spindles may be had over a wide range of sizes as well as styles. We are prepared to build them as large or as small as you may need.

Be They Large Or Be They Small

POPE Will Build Them For You

POPE builds into a spindle what it takes to do the job right and to keep on doing it right.

POPE engineering skill and POPE precision craftsmanship are devoted exclusively to the development and production of the best possible spindle for the job. This means plenty of steel, plenty of bearings of the right kind, size and quality, and above all, skilled engineering and fine workmanship.

POPE Spindles feature Sealed Lubrication, specially selected precision bearings, rugged ability to stand up under hard work and at the same time to produce a better final finish.

★ ★ ★

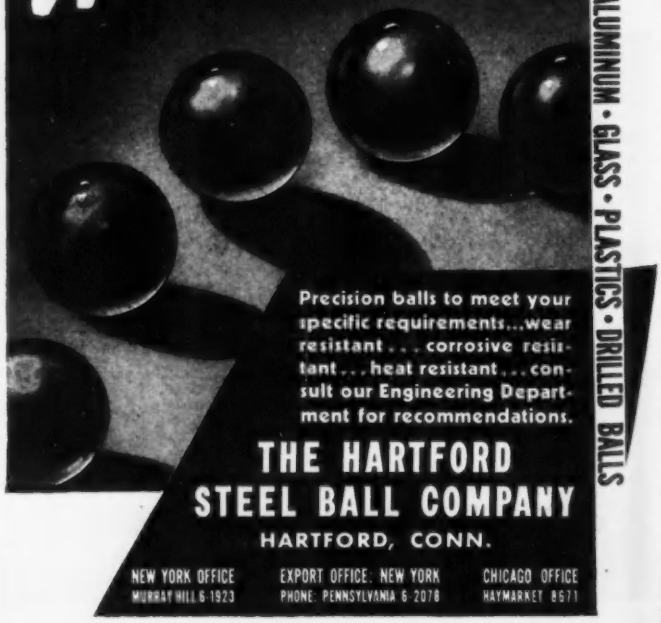
Send us a sketch or description of the spindle you require and we will furnish you cost and delivery estimates.

POPE MACHINERY CORPORATION
ESTABLISHED IN 1920
HAVERHILL, MASSACHUSETTS
BUILDERS OF PRECISION SPINDLES

CHROME ALLOY • CARBON STEEL • STAINLESS STEEL • BRONZE • K-MONEL • ALUMINUM • GLASS • PLASTICS • DRILLED BALLS

SPECIFY

Hartford PRECISION BALLS



Precision balls to meet your specific requirements...wear resistant... corrosive resistant... heat resistant... consult our Engineering Department for recommendations.

THE HARTFORD STEEL BALL COMPANY

HARTFORD, CONN.

NEW YORK OFFICE MURRAY HILL 6-1923 | EXPORT OFFICE: NEW YORK PHONE: PENNSYLVANIA 6-2078 | CHICAGO OFFICE HAYMARKET 8671

Aluminum Propeller Output INCREASED 55% with TOCCO Induction Heating

A LARGE manufacturer of automotive and aircraft parts reports these improvements in the heating for upsetting of aluminum propeller hub flanges for many of our fighters and bombers, including the B-29 Superfortress:

The former batch heating method—hot, dirty, cumbersome and non-uniform—required 2½ hours to heat the hubs. Total output averaged 45 per hour.

The 5-station TOCCO Induction Heating machine shown above—compact, clean, cool and accurate—heats 9″ of the 5¼″ diameter hubs to 800-850° F. uniformly throughout both length and cross-section. Every 47½ seconds, a prop is ready for the upsetter which is shown at the left of the TOCCO machine. Output of this one TOCCO unit averages 70 per hour . . . 55% faster than former method.

Find out how TOCCO can speed up your war production . . . improve your products and working conditions . . . cut your postwar costs. Write for free copy of "Results with TOCCO".

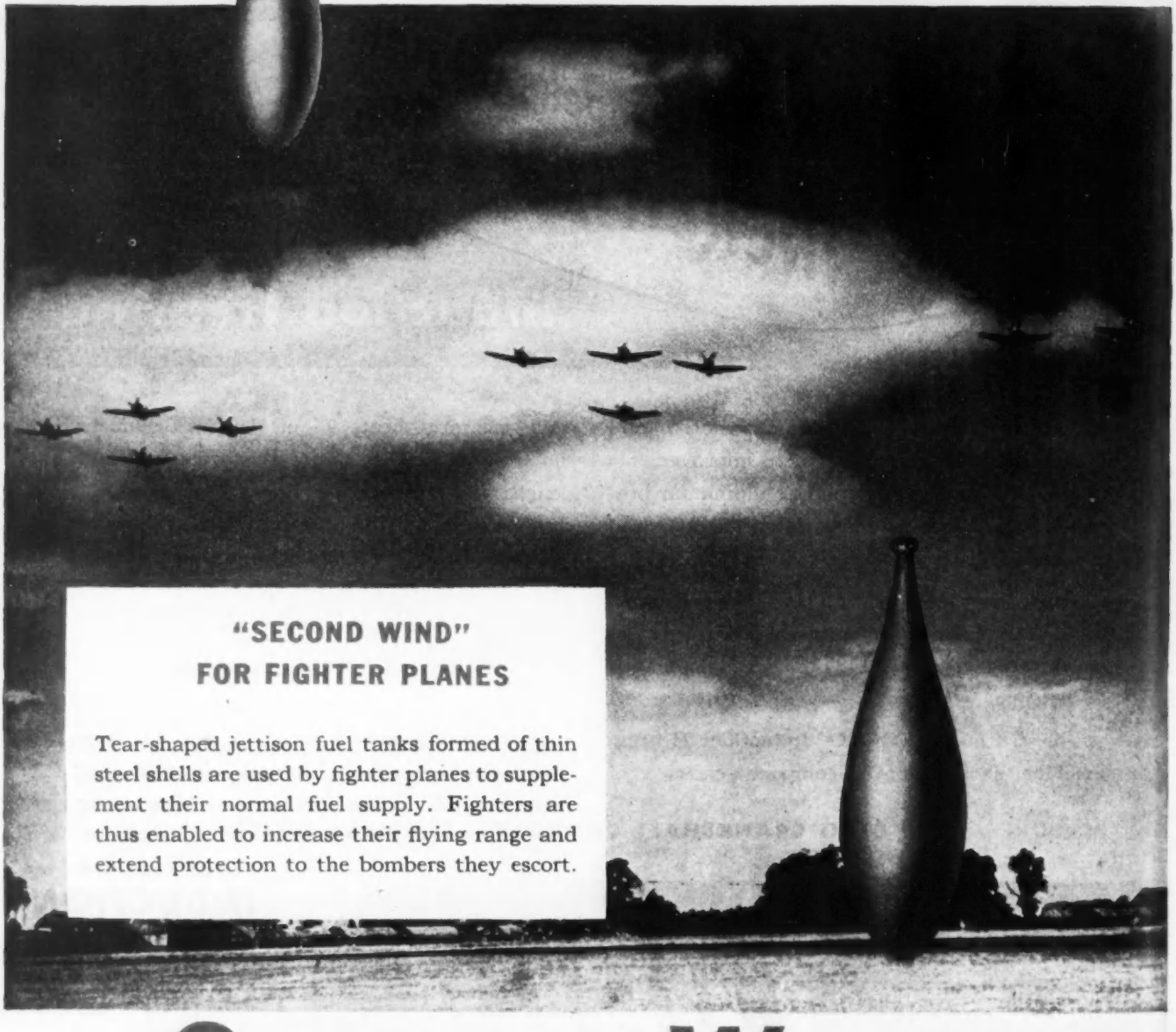
THE OHIO CRANKSHAFT COMPANY • Cleveland 1, Ohio

TOCCO

INDUCTION
HARDENING . . BRAZING
ANNEALING . . HEATING

"TOUGH HIDES"

for Thin Shells



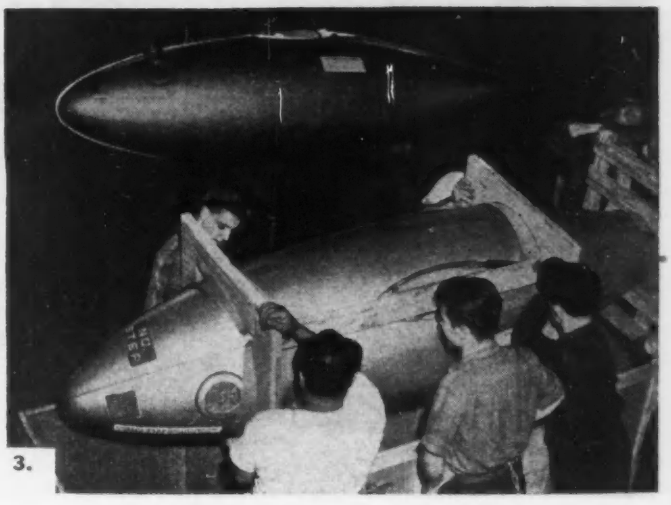
"SECOND WIND"
FOR FIGHTER PLANES

Tear-shaped jettison fuel tanks formed of thin steel shells are used by fighter planes to supplement their normal fuel supply. Fighters are thus enabled to increase their flying range and extend protection to the bombers they escort.

SHERWIN-WILLIAMS

1.

2.



3.

1. THE FLOAT TEST. Each jettison fuel tank at MacKenzie Muffler Company's plant in Youngstown, O., gets final test with compressed air in water tank to insure that it will hold gas without leaking.

2. PAINT FOR PROTECTION! After testing, final coat of Sherwin-Williams finish is sprayed on every tank in special painting and drying racks for protection against corrosion and abrasion!

3. READY TO GO! Protected against external corrosion and abrasion by Sherwin-Williams finishes, tanks are packed into individual cases ready for shipment—and one-way passage on a fighter plane.

MacKenzie Jettison Fuel Tanks protected by *SHERWIN-WILLIAMS* finishes!

When the MacKenzie Muffler Company—world's largest manufacturer of jettison fuel tanks—began production, they had to be sure these delicate, lightweight steel shells would withstand handling and exposure to the elements. With the cooperation of Sherwin-Williams industrial finishing specialists, a finish was developed that does the job on all counts—a "tough hide" that assures protection against external corrosion and abrasion.

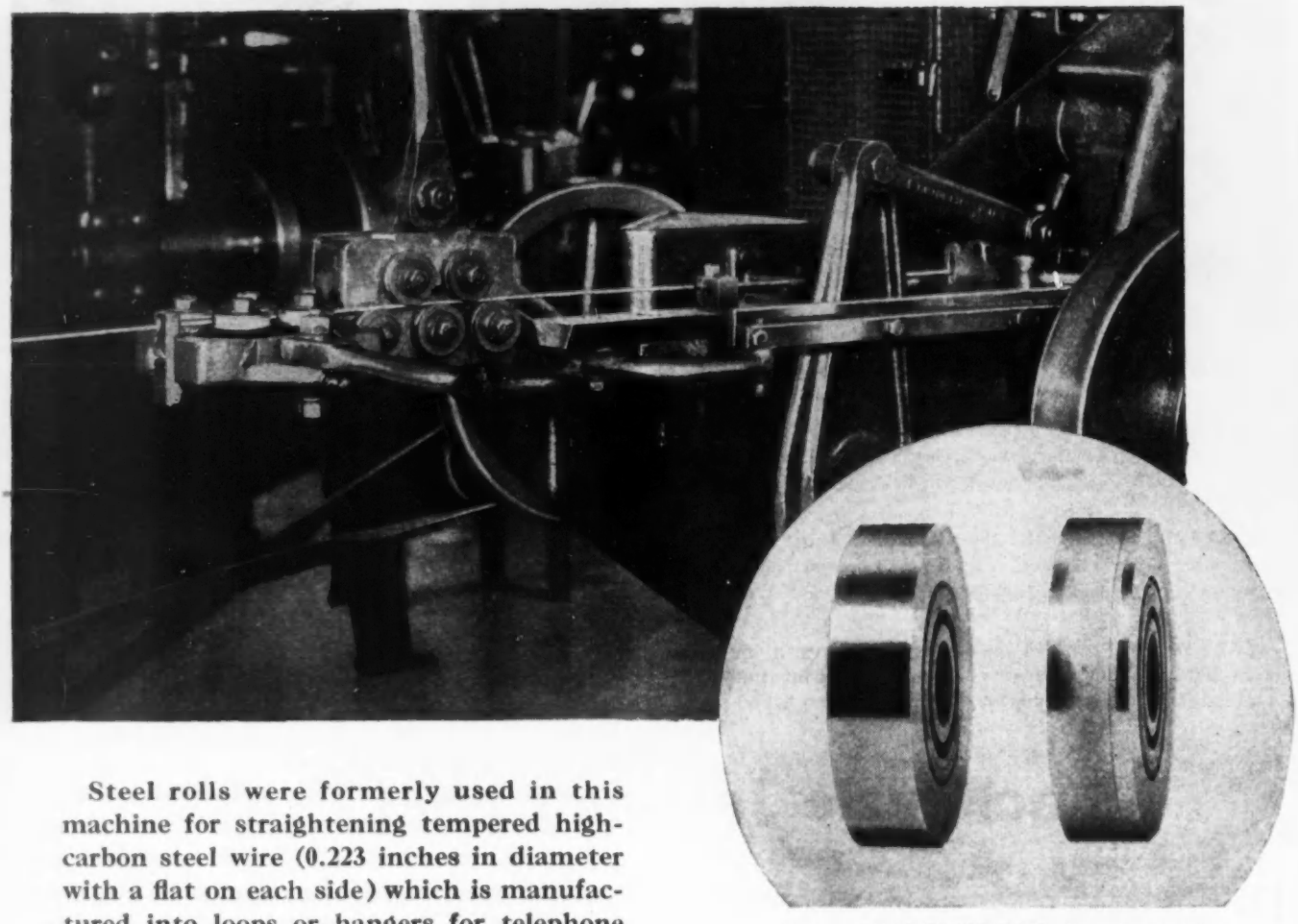
Four Sherwin-Williams products are used, each one performing a special protective function: Zinc Chromate Primer, Camouflage Gray No. 43, Opex Clear Lacquer and Opex Navy Gray Lacquer. The resultant hard, firm, even finish resists deterioration... conforms to Navy camouflage specifications ... and further reduces the low wind resistance effected by the tanks' stream-lined design.

Sherwin-Williams materials, experience and technical knowledge are also available to *you*, on both present and post-war production. Write The Sherwin-Williams Co., Cleveland 1, Ohio.

INDUSTRIAL FINISHES

HAYNES STELLITE Alloy Rolls

Last 30 Times Longer Than Steel Rolls in This Wire-Straightening Machine



Left, new HAYNES STELLITE alloy wire-straightening roll. Right, HAYNES STELLITE alloy roll after years of continuous service.

Steel rolls were formerly used in this machine for straightening tempered high-carbon steel wire (0.223 inches in diameter with a flat on each side) which is manufactured into loops or hangers for telephone cables. Severe abrasion caused a complete set to wear out every three or four months.

It was a different story after the steel rolls were replaced by rolls of a hard, wear-resisting HAYNES STELLITE alloy. After ten years, the alloy rolls were still giving good service... demonstrating again the abrasion-resistance of HAYNES STELLITE alloys.

Haynes Stellite Company makes many alloys with resistance to heat, wear, abrasion, and corrosion. Our engineers can help you select a HAYNES STELLITE alloy with the right range of properties to meet the requirements of your particular application. You can get further information on these alloys by writing for the booklet "Products of Haynes Stellite Company."

BUY UNITED STATES WAR BONDS AND STAMPS

HAYNES STELLITE TRADE-MARK

HAYNES STELLITE COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

General Office and Works, Kokomo, Ind.

Chicago—Cleveland—Detroit—Houston—Los Angeles—New York—San Francisco—Tulsa

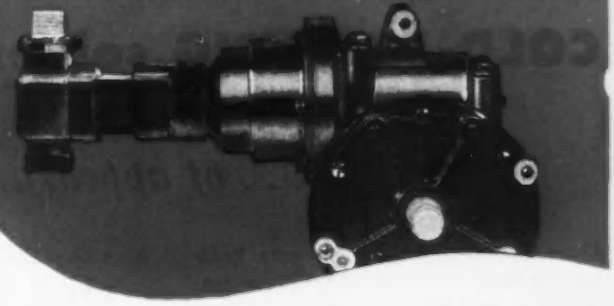
ABRASION- AND CORROSION-RESISTANT ALLOYS

"HAYNES STELLITE" is a registered trade-mark of Haynes Stellite Company.

All Remote Control Motors

ON THE NEW A-26

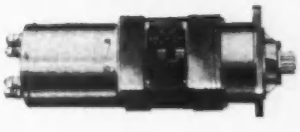
Data: Oil cooler door actuating motor, ⅛ hp — Equipped with magnetic clutch and brake — Compound planetary reduction of 478 to 1, with additional worm and sector reduction of 30 to 1 gives a total reduction of approximately 15,000 to 1 — Maximum torque on the drive shaft is 6,000 inch-pounds — For use in a 28-volt system.



Within the Douglas A-26 Invader, newest and fastest all purpose attack bomber of the Army Air Forces, necessary flight and combat functions are performed by electrically operated remote control motors. Each of the compact, self-contained EEMCO motor-actuators is custom built to precise job specifications covering work, load and weight factors, mounting conditions and restrictions, altitude and temperature variants, overall operating efficiency and ease of maintenance.

The EEMCO cowl flap actuators, gun mount trigger motors and cabin heater blower motors designed for the A-26 are as unique in design as the two shown here.

Completely engaged today in engineering and building out-of-the-ordinary electric motors for special Army and Navy needs, EEMCO has the experience and ability to help solve your *tough* motor problems. Let EEMCO engineers go over your war time motor requirements with you *now*, and later discuss electric drive applications for your peace-time production or products.



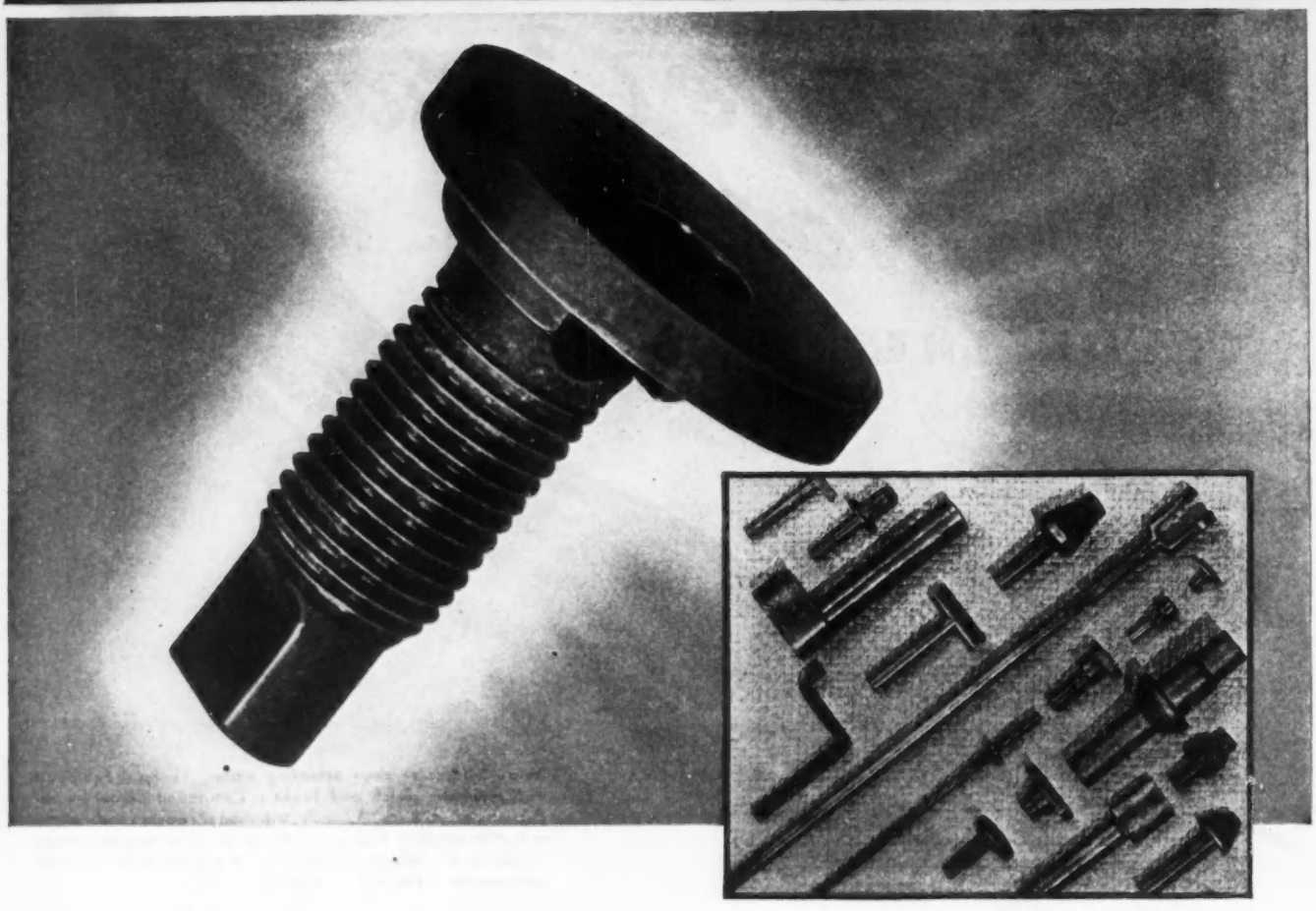
Data: Wing flap actuating motor, 2 hp, 7500 rpm, intermtitent duty type — Equipped with magnetic clutch and brake — Thermally protected — Additionally protected from exposure to dust, sand and salt spray — Unit designed for low impact torque, to prevent damage in the event of overtravel caused by failure of electrical stops.

Send in your reservation today for "Custom Built Motors for a World of Needs," now in preparation. Copies of this limited edition will be distributed only on written request.

EEMCo

ELECTRICAL ENGINEERING AND MFG. CORP.
4606 West Jefferson Boulevard, Los Angeles 16, California

100 YEARS *Making strong the things that make America strong*



COLD-FORGING solves many problems

. . . of strength . . . of accuracy . . . of appearance . . . of cost

There are various reasons why cold-forging was selected as the best or perhaps the *only* efficient method of producing these parts.

Some were cold-forged in order to obtain maximum *strength*. Proper cold-working definitely increases tensile strength and also provides an automatic inspection of the material.

Others were cold-forged because *accuracy* of dimension and fine *appearance* were paramount considerations. That modern cold-upsetting equipment can meet such specifications is evidenced by the billions of fastening parts for aircraft service that have been made by this method.

And in many cases, the *economy* of the method made it attractive. The high speed of RB&W's cold-forging machinery reduces cost below that of other methods which require several or slower operations. With practically no scrap waste, there is also a saving in weight of metal required.

100 YEARS EXPERIENCE

1945 marks RB&W's 100th year in the production of high-quality fastening products. Its experience in automatic cold-forging—the longest of any manufacturer—will be helpful to you in determining the most efficient means of obtaining parts like those shown above. Plan to make use of RB&W facilities when they are again available upon completion of war assignments.

RB&W

Russell, Burdsall & Ward Bolt and Nut Company . . . *Factories at* Port Chester, New York, Coraopolis, Pa., Rock Falls, Ill., . . . *Sales offices at* Philadelphia, Detroit, Chicago, Chattanooga, Los Angeles, Portland, Seattle . . . with the industry's most complete, easiest-to-use catalog.

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

CONTROLLED COOLING...

gave added strength to this PERMITE PERMANENT MOLD Aluminum Casting

When molten aluminum solidifies inside the metal walls of a permanent mold, the metal surfaces hasten the cooling process. This rapid cooling results in a finer grained casting, with greater tensile strength. Thus, in many cases it is possible to safely reduce the thickness of sections, with a saving in metal, weight and money.

Increased tensile strength is but one of the important advantages of the permanent mold process. As used at Permite, this process produces aluminum castings of precise dimensions, uniformly maintained. Permite Aluminum Castings, produced in permanent molds, can be held to a dimensional tolerance of ± .010", compared to the standard of ± .030" for sand castings.

Low production costs and advanced refinements are essential for products planned for today's markets. One of our technical representatives will be glad to show how Permite Permanent Mold Aluminum Castings may help you attain these essentials in your products. Recommendations and estimates submitted without obligation.

ALUMINUM INDUSTRIES, Inc.
CINCINNATI 25, OHIO

Detroit: 809 New Center Building
Los Angeles: 324 North San Pedro Street
Chicago: 616 South Michigan Avenue
New York: 9 Rockefeller Plaza
Atlanta: 413 Grant Building

PERMITE ALUMINUM ALLOY CASTINGS

VITAL WAR MATERIALS *for* ALLIED VICTORY!

ACADIA *Synthetics*

Acadia Synthetics, molded, extruded or cut to exacting tolerances, play an important part in helping to keep running machines of war, and the machines that make them. Compounds suited to your specifications are also available for Army, Navy and A. M. S. specifications.

Resistant to oils, petroleum products, air, light, ozone, age—Acadia Synthetics combine properties found in natural rubber with some that are not, to meet specific job requirements.

Acadia engineers will help you determine the best Synthetic Rubber compound to meet your requirements, without obligation.

Write today for the new Data Book of Acadia Synthetic Rubber.

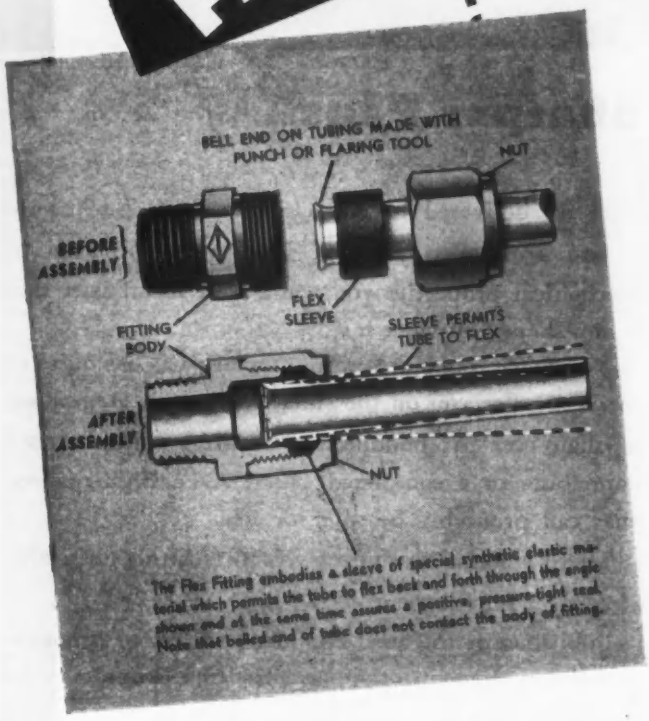
ACADIA *Synthetic* **PRODUCTS**

Processors of Synthetic Rubber and Plastics • Sheets Extrusions • Molded Parts

DIVISION WESTERN FELT WORKS

LARGEST INDEPENDENT MANUFACTURERS AND CUTTERS OF FELT

4035-4117 Ogden Avenue • Chicago 23, Illinois ***Branch Offices in All Principal Cities***


BELL END ON TUBING MADE WITH PUNCH OR FLARING TOOL
NUT
BEFORE ASSEMBLY
FLEX SLEEVE
FITTING BODY
SLEEVE PERMITS TUBE TO FLEX
AFTER ASSEMBLY
NUT
The Flex Fitting embodies a sleeve of special synthetic elastic material which permits the tube to flex back and forth through the angle shown and at the same time assures a positive, pressure-tight seal. Note that belled end of tube does not contact the body of fitting.

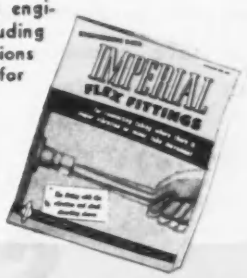
The Flex Fitting differs from ordinary tube fittings in that it makes a joint which actually permits the tube to flex.

It is unsurpassed for use where there is major vibration or minor tube movement . . . where tubing lines must stand up under heavy pounding service. Flex Fittings are already being used as standard equipment by many manufacturers of Diesel engines, trucks, tractors, oil filters, carburetors, heavy power equipment, etc.

Consider Flex Fitting advantages:

1. Makes a joint that is virtually indestructible by vibration and that will withstand considerable mechanical shock.
2. Eliminates need for costly flexible hose lines in many instances.
3. Can be used with all kinds of metal tubing—seamless or seamed.
4. Easy and speedy to install. Can be disconnected and reconnected repeatedly without danger of leakage.
5. Proved by extensive service in the field.

Catalog No. 344 gives complete engineering data on Flex Fittings, including types, sizes, dimensions, specifications and application information. Write for your copy.

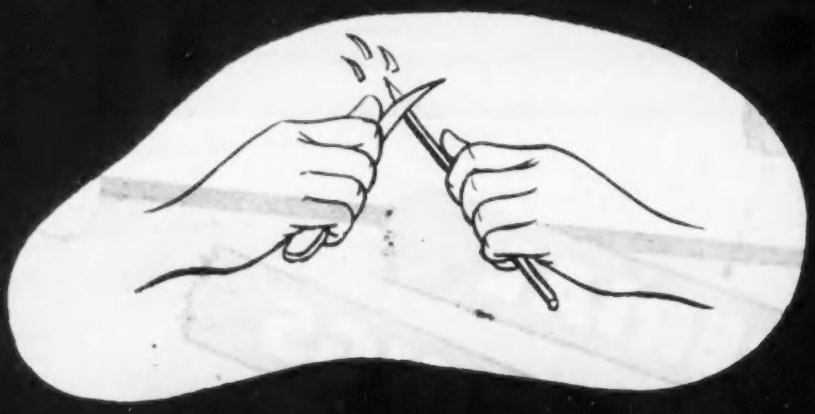


THE IMPERIAL BRASS MANUFACTURING COMPANY
515 South Racine Ave., Chicago 7, Ill.

IMPERIAL

Headquarters for Tube Fittings and Tube Working Tools

BETTER STEEL CASTINGS THROUGH RESEARCH



You may need a Sharper Pencil

We are not very far away from a period of pretty stiff competition.

Industry has learned to produce in tremendous volume, and has vastly larger facilities for production.

The selling job to be done to move these goods at a profit is a bigger one than we have ever tackled. Hence, cost of production will be something to worry about.

Steel Casting research has long been pointed at lower costs for improved end results.

For instance, one way of cutting corners is to combine two or more parts in a single steel casting — to save assembly time and handling. And you can cut finishing time through steel castings that are delivered to you close to final dimensions.

You save when you can get any combination of mechanical properties you want, in a metal part that is any shape you want it.

No other process of forming metal parts has quite so much to offer you on the side of economy. Regardless of their cost per pound, steel castings almost always contribute to a completed article, of a high quality, that can profitably be sold for less.

There is sound reason for you to talk this over with your steel foundryman.

Published by the Steel Founders' Society of America to tell you about its organized Research Program.

MODERNIZE AND IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

Advertisement FEBRUARY, 1945

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Brass and Copper for Deep Drawing, Spinning and Stamping

Wide Range of Physical Properties

Space does not permit a complete discussion of the many advantages of brass for drawing, spinning and stamping. Through long usage its fine appearance, wearability, non-rusting properties and lasting satisfaction are taken for granted by users of brass products. Only when it is necessary to use substitute materials are the fine characteristics of brass most fully appreciated. The manufacturer, on the other hand, thinks of brass in terms of easy workability, less wear on tools, economy when a number of fabrication operations are involved, and ease of attractive, durable plating and finishing.

Manufacturers striving for lower costs through greater efficiency seek materials which are of correct composition, gauge, temper, surface, coil length, etc. Laboratory skill, modern manufacturing methods and close cooperation can work wonders by increasing quality and cutting waste, labor and materials through reduction of unnecessary scrap.

The physical and mechanical properties of six alloys, ranging from high brass to gilding metal, together with standard grades of copper, are listed herewith. Included are recent specifications and brief descriptions of their most popular uses. Keep this bulletin for future reference. We shall be glad to supply extra copies as long as they are available.

High Brass (approximately 66% copper, balance zinc) color, bright yellow. Most widely used alloy of the brasses. Suitable for a great variety of drawing, forming, spinning, stamping and etching operations. Has many applications in the manufacture of building hardware, electrical sockets and other parts, auto lamp reflectors and accessories, novelties, gift items, etc.

70-30 Brass (approximately 70% copper, balance zinc) color, bright yellow. Known as cartridge brass. Because of greater strength and higher ductility than high brass it is universally used for the manufacture of artillery cartridge cases and small arms ammunition; for deep drawn and spun parts such as musical instruments; for the manufacture of eyelet machine items, and products made by progressive machine operations. 70-30 brass is also used for making parts requiring extra deep draws with fewer intermediate anneals than high brass.

Low Brass (approximately 77% to 82% copper, balance zinc) color, light golden. Very ductile. For making flexible metallic hose, metal bellows, clock dials, medallions, etc.

Red Brass sometimes known as "rich low" (approximately 82% to 87% copper, balance zinc) color, deep golden. Very ductile. Widely used for water pipe and auto radiator cores, because of its corrosion resistance; vanity cases and inexpensive jewelry because its color resembles 14K gold. Also used for weather strip, fire extinguishers, because of its resistance to weathering and season cracking.

Commercial Bronze (approximately 87% to 94% copper, balance zinc), rich, warm bronze color. Has great ductility. Resists weathering, corrosion and season cracking. For outdoor electric light fixtures, hardware, costume jewelry, grilles, screen cloth, primer caps, screw shells.

Gilding Metal (approximately 94% copper and over, balance zinc) color, light copper. Great ductility and resistance to season cracking and corrosion. Used for enamelled jewelry, escutcheons, nameplates, bullet jackets.

Copper for Fabrication

Can be worked either hot or cold. When cold worked does not harden as rapidly

(*Continued on page 2, column 2*)

BRASS AND COPPER STRIP—*For Drawing, Spinning and Stamping*

		High Brass	70-30 Brass	Low Brass	Red Brass	Com. Bronze	Gilding Metal	Copper Elec. Tough Pitch
ANALYSIS								
Copper %		66.0	70.0	80.0	85.0	90.0	95.0	99.92
Lead %								
Tin %								
Zinc %		34.0	30.0	20.0	15.0	10.0	5.0	
Oxygen								0.04
MECHANICAL PROPERTIES								
Ten. Strength psi	Hard*	74,000	76,000	74,000	70,000	61,000	56,000	50,000
	Soft	47,000	47,000	44,000	40,000	38,000	35,000	34,000
Yld. Strength psi (@½ % extens. under load)	Hard*	60,000	63,000	59,000	57,000	54,000	50,000	45,000
	Soft	15,000	15,000	14,000	12,000	12,000	11,000	11,000
Elongation % in 2"	Hard*	8	8	7	5	5	5	6
	Soft	62	62	50	47	45	45	45
Rockwell Hardness	Hard*	B80	B82	B82	B77	B70	B64	B50
	Soft	F64	F64	F61	F60	F57	F52	F45
PHYSICAL CONSTANTS								
Melting Pt. (Liq)°F		1710	1750	1830	1880	1910	1950	1981
Density, lbs. cu. in.		0.306	0.308	0.313	0.316	.318	.320	.321-.323
Coeff. Therm. Exp. per °F from 77°F to 572°F x10-6		11.3	11.1	10.6	10.4	10.2	10.0	9.8
Thermal Conduct. Btu sq ft/ft/hr °F @ 68°F		67	70	81	92	109	135	226 192 (a) 228 (b)
Elec. Cond. % IACS @ 68°F Soft		27	28	32	37	44	56	101 85 (a) 102 (b)
Mod. of Elas. (Tension) psi.		15,000,000	16,000,000	16,000,000	17,000,000	17,000,000	17,000,000	17,000,000
FABRICATION PROPERTIES								
Machinability Rating**		30	30	30	30	20	20	20
Cold Working		E	E	E	E	E	E	E
Hot Working		P	F	F	G	G	G	E
Hot Working Range °F			1350-1550	1500-1650	1450-1650	1400-1600	1400-1600	1400-1600
SPECIFICATIONS								
A.S.T.M.		B36-43T Alloy #8	B36-43T Alloy #6	B36-43T Alloy #4	B36-43T Alloy #3	B36-43T Alloy #2	B36-43T Alloy #1	B152-42T
Federal		QQB611A Comp C	QQB611A Comp E					QQC501A
Navy		47B2INT Aug. 15, 1944	OS1331 47B2INT Aug. 15, 1944				OS819	47-C-2f
Army			(57-172-10) (57-173B)	57-160	57-160	57-171-1B	57-171-2	57-226A
AMS			4505A					4500

(a) Phosphorized Copper (b) Oxygen Free Copper E—Excellent G—Good F—Fair P—Poor
*Hard temper values are for strip reduced 4 B & S gage numbers in thickness by cold rolling.
All figures are nominal values and should not be used as specifications. **Machinability rating.

CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, research chemist of the Bridgeport Brass Company.

ACCELERATED CORROSION — Cold Wall Effect (*Cont.*)

We shall now consider the "cold wall effect" in relation to stress corrosion cracking. The contamination of a condensate by ammonia or ammonium compounds from steam or the products of combustion (from coal or gas fired furnaces and water heaters) may lead to stress corrosion cracking of stressed brass condenser tubes or basement cold water pipes. This type of corrosion is found in plants such as oil refineries where ammonia gas is used for neutralizing acid vapors. Stress corrosion is much more localized than the corrosion grooves described in our previous discussion, and is characterized by very narrow cracks which penetrate the metal from the surface facing the corrosive atmosphere or solution. See microstructure illustration in figure 1. There may be a single crack, which eventually opens up as shown in figure 2, or a network of many cracks.

Fig. 1. Photomicrograph of yellow brass tubing showing transcrystalline cracks starting at surface.

The time required to penetrate a yellow brass rod, sheet or tube varies considerably depending primarily upon the combined action of:

1. Amount of ammonia or similar nitrogen compounds.
2. Magnitude of the stresses.
3. Inherent susceptibility of the alloy to this specific type of attack.
4. Amount of water vapor.
5. Amount of air.

If conditions are severe enough, stress corrosion on the outside of a cold tube or pipe may proceed much more rapidly than the type of corrosion occurring on the inside.

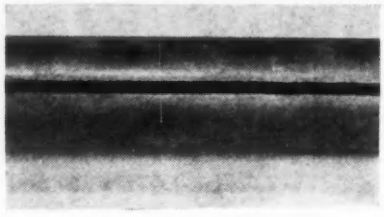


Fig. 2. Yellow brass tube with fully developed crack.

Brass and Copper

(*Continued from page 1*)

as other materials, and consequently, will stand severe cold working with fewer intermediate annealing operations. It will soften above 450°F. Since it oxidizes readily at elevated temperatures, its surface should be protected by a reducing or neutral atmosphere during annealing. Copper can be readily polished and plated, and will take on beautiful finishes. Copper is used in the manufacture of electrical equipment such as electric switches, terminals, lighting fixtures, serving trays, percolators, creamers and sugar bowls, electrical appliances, radios, automobile radiators, gift items, clock cases, enamelled goods, cooking utensils, garden sprayers, concrete road expansion joints.

Electrolytic Tough Pitch Copper (contains small quantity of copper oxide). Used in far greater quantities than other grades. Has high electrical conductivity and can be stamped, formed, spun, brazed or soldered. Not suitable for oxyacetylene welding because it tends to become brittle at some distance from the weld.

Phosphorized Copper (deoxidized with phosphorous). Has lower electrical conductivity than tough pitch copper. Used for operations involving extra deep drawing or flanging. Can be welded by the oxyacetylene method without becoming brittle.

Oxygen Free Copper. Has high electrical conductivity and is free from both phosphorous and cuprous oxide. Suitable for extra deep draws. Used where pure copper is required, i.e. radar, electronics and other exacting electrical requirements.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

A Saw Blade for the rapid cutting of ferrous and non-ferrous alloys has an innovation in the design of teeth to permit rapid production, parallelism and close tolerance over the entire finished cut, according to a recent announcement. **No. 590**

Plexiglas Masking Jigs are available for copper plating. Machinability, dimensional stability, and light weight are said to make this material valuable in reducing rejects and in stepping up production rates. Carbon rings to be plated are inserted in grooves 1/64 in. wide on either side of the Plexiglas jig rings. **No. 591**

A New All-Purpose Disc Grinder, said to be suitable for use with any type of metal, wood or plastic material, is available in 3- and 5-h.p. models. Principal features claimed are (1) a 30-in. disc with 26-in. high grinding area; (2) hydraulic controls that eliminate all gears, worms and jack screws ordinarily employed for raising, lowering and tilting the table; (3) an accurate position stop provided on protractor for stopping table in any position from 45° down to 15° up; (4) ventilated table with properly placed perforations to channel dust into highly efficient dust guards; and (5) paper or cloth abrasive discs may be removed and replaced without removing the steel disc. **No. 592**

Dependable Temperature Regulation is reported with a new control for electrically heated furnaces, ovens, and similar units. An on-off contacting system feeds to the heating unit the current needed to hold temperature to the required control point or program. Input is either full-on or full-off. Regulation is obtained by controlling automatically the time during which current is on and off. Other features reported are full proportional time action, automatic drop-correction, and optional "overshoot control" for use in bringing temperature up to desired heat. **No. 593**

Revised Duronze Manual

Revised Manual with new tables, curves and other physical data now off the press. If interested in improving existing products or making new ones, be sure to write for a free copy of this 80-page technical booklet.

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT 2, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze*, for stamping, deep drawing, forming and spinning.

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PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

"Bridgeport" BRASS

Established 1865

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware: *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

COPPER WATER TUBE.

FABRICATING SERVICE DEPT.—Engineering staff.

BRASS AND COPPER PIPE

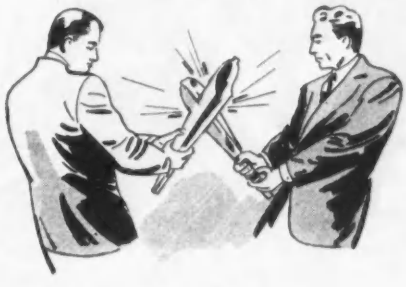
Note: Bridgeport products are supplied in accordance with existing priority regulations.

*Trade name.

BRIDGEPORT ARMY E NAVY **BRASS**

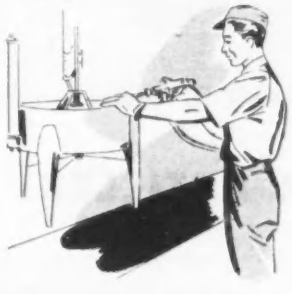
PROTECTION, BEAUTY and FASTER FINISHING SPEEDS

How a Polymerin Finish Gives You All Three!



PROTECTION! Impartial tests have proved Polymerin*9 times harder to chip than ordinary enamels. Polymerin resists marring, humidity, heat, grease and other common deteriorants.

BEAUTY! A Polymerin finish adds to your product's "eye appeal". Polymerin is formulated in a full line of lasting colors, non-yellowing white and clear.



FINISHING SPEED! Polymerin is the original speed-bake finish. Baking speeds as low as 1 or 2 minutes help you to maintain fast production schedules and cut finishing costs.

"THE FACTS ON POLYMERIN"

"The Facts On Polymerin" gives, industry by industry, many examples of *how* and *why* Polymerin has been used by leading manufacturers. You will want this information before you plan the finish for your postwar products. Use the coupon below to send for a free copy of "The Facts On Polymerin" today. Regular Polymerin is not available now. But Polymerin-200, a new finish that can be handled exactly the same as regular Polymerin and which is comparable in flow, flexibility, durability and lustre, is giving very satisfactory results in many applications.

A&W POLYMERIN

The Original Speed-Bake Finish

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Please send, without obligation, a copy of "The Facts On Polymerin"—the booklet which gives, industry by industry, many examples of *how* and *why* Polymerin has been used by leading manufacturers.

Name _____

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I am primarily interested in finishes for

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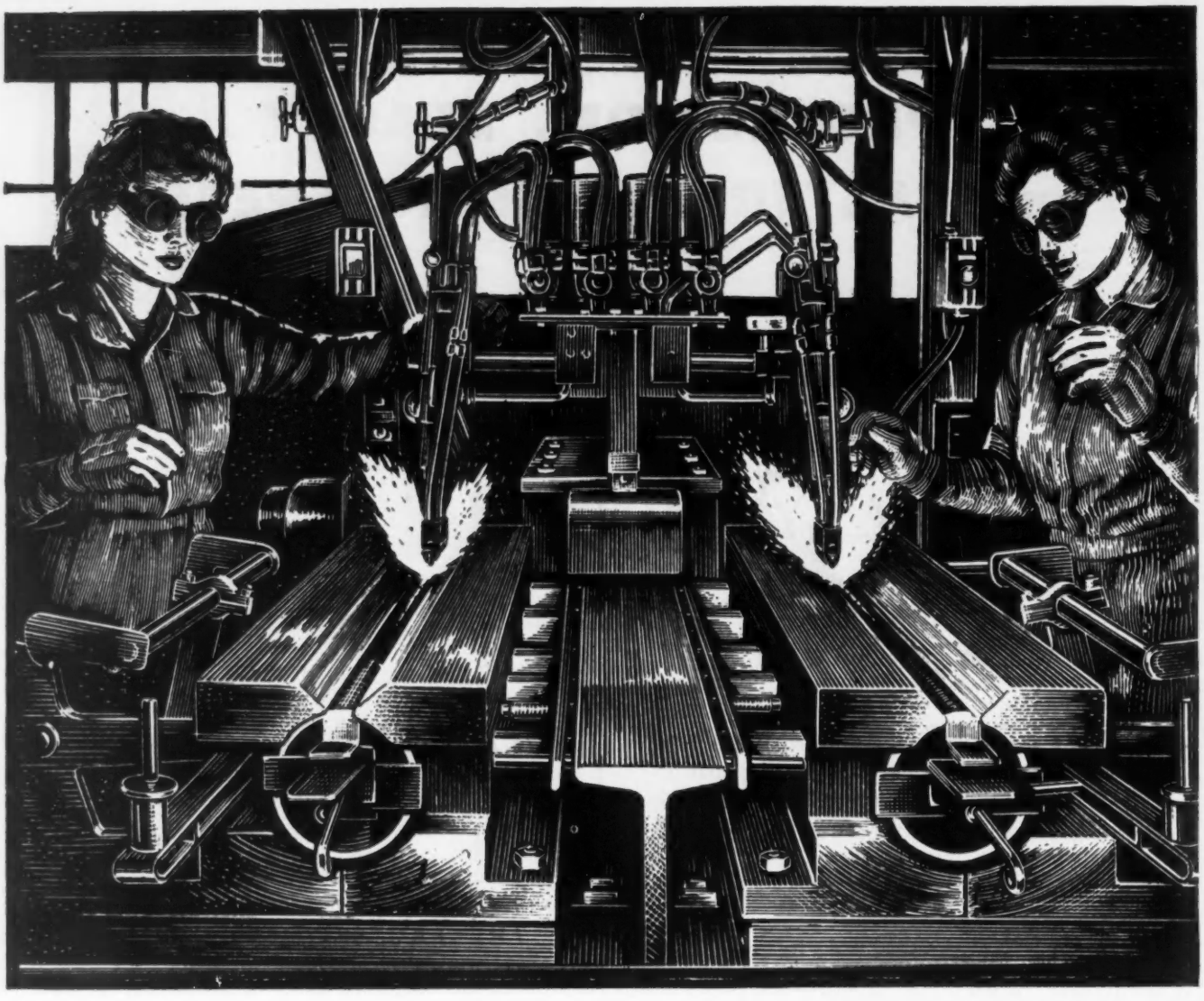

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FLAME STITCHING COVERALLS FOR ARTILLERY SHELLS

SHELLS need protection against corrosion and other surface damage during their long journey to our global firing lines. Each shell is encased in a metal container—a "coverall" that preserves the lethal traveler on the long trip from arsenal to artillery post.

Automatic oxyacetylene flame welding machines perform the main tailoring operation in producing these metal shell-containers. Open seam tubes that have been formed from flat metal sheets are placed into each of ten identical welding machines, two of which are shown above. Then at the push of a button, all ten torches move as one, automatically stitching up the open seams. The operation takes only a minute . . . and the seams are tight and permanent.

This mechanical welding operation—developed in wartime by Airco Engineers—presents interesting opportunities for postwar manufacturing. It combines unusual speed with a high degree of weld uniformity, features that make for increased economy and reduced rejects.

Air Reduction's Applied Engineering Division will be glad to provide complete details on mechanical gas welding and other work-speeding flame and arc methods. For further information, or technical aid in using these modern methods, write to Dept. PD, at the New York office.

★ BUY UNITED STATES WAR BONDS ★

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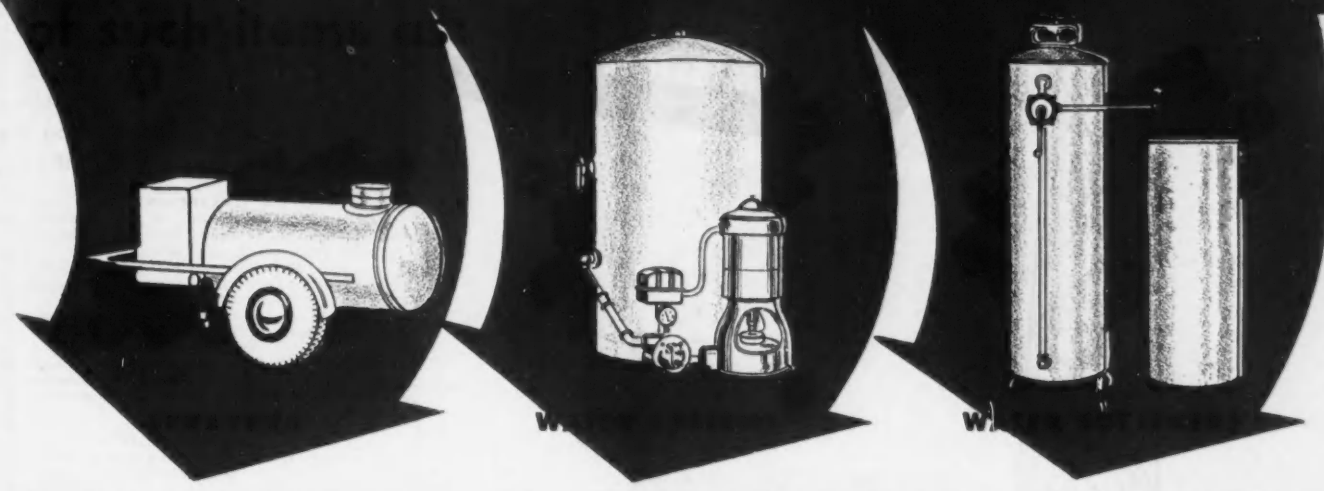
Offices in all Principal Cities

A MESSAGE



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Here's an unnecessary cost that Brownie can help you avoid. The high shipping and handling costs you now pay when you send a *complete* unit (with tank) across the country are largely due to the weight, size and bulk of the tank itself, and the long travel involved.

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Brownie craftsmen will then install necessary tanks on your products *exactly* as you direct, box assembled units carefully, and reship to your jobbers in nearby states . . . at *less* total cost to you.

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WHERE costly installations are exposed to the elements and rust prevention is of first importance—Hot-Dip Galvanizing proves its own case. Day in and day out it pays its own way in longer, uninterrupted service and savings from replacement and maintenance costs.

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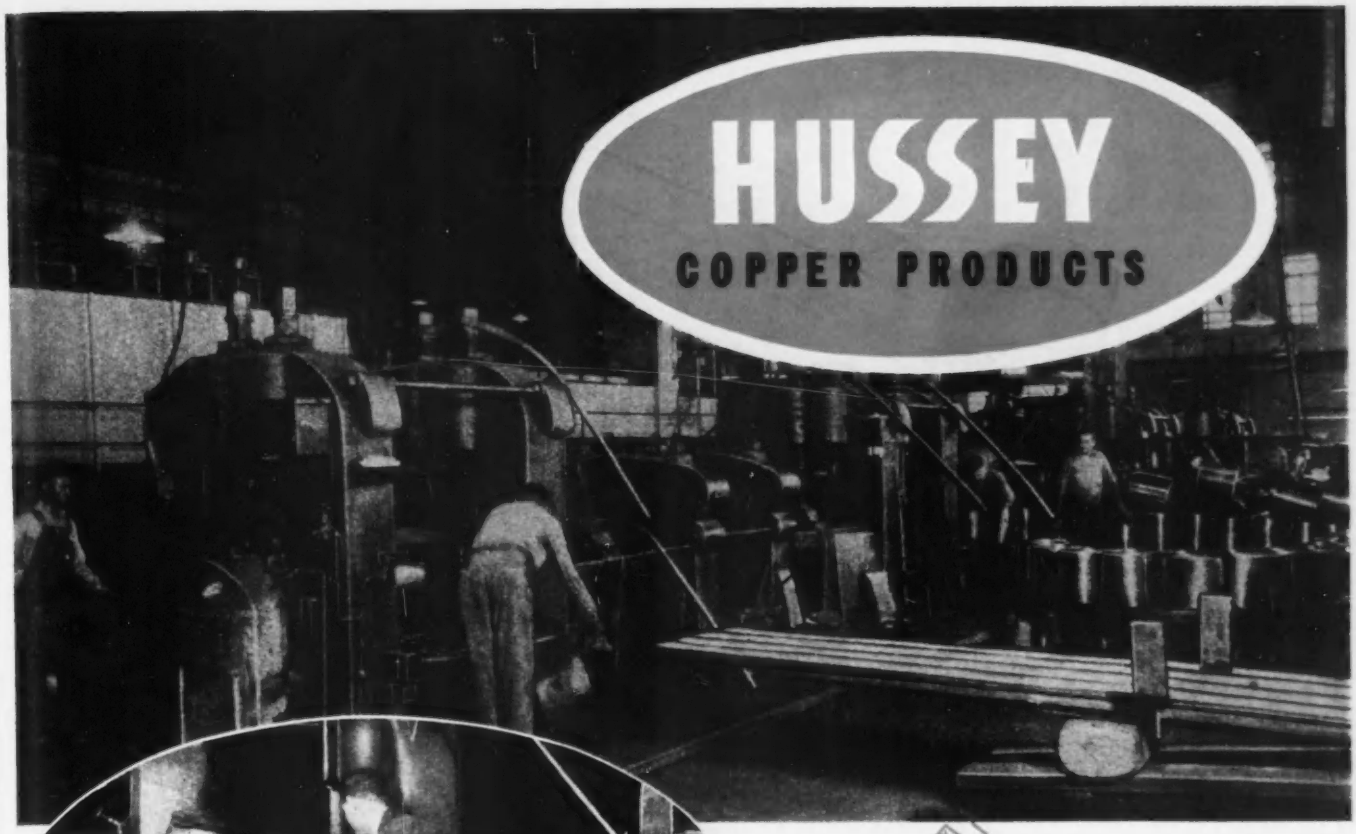

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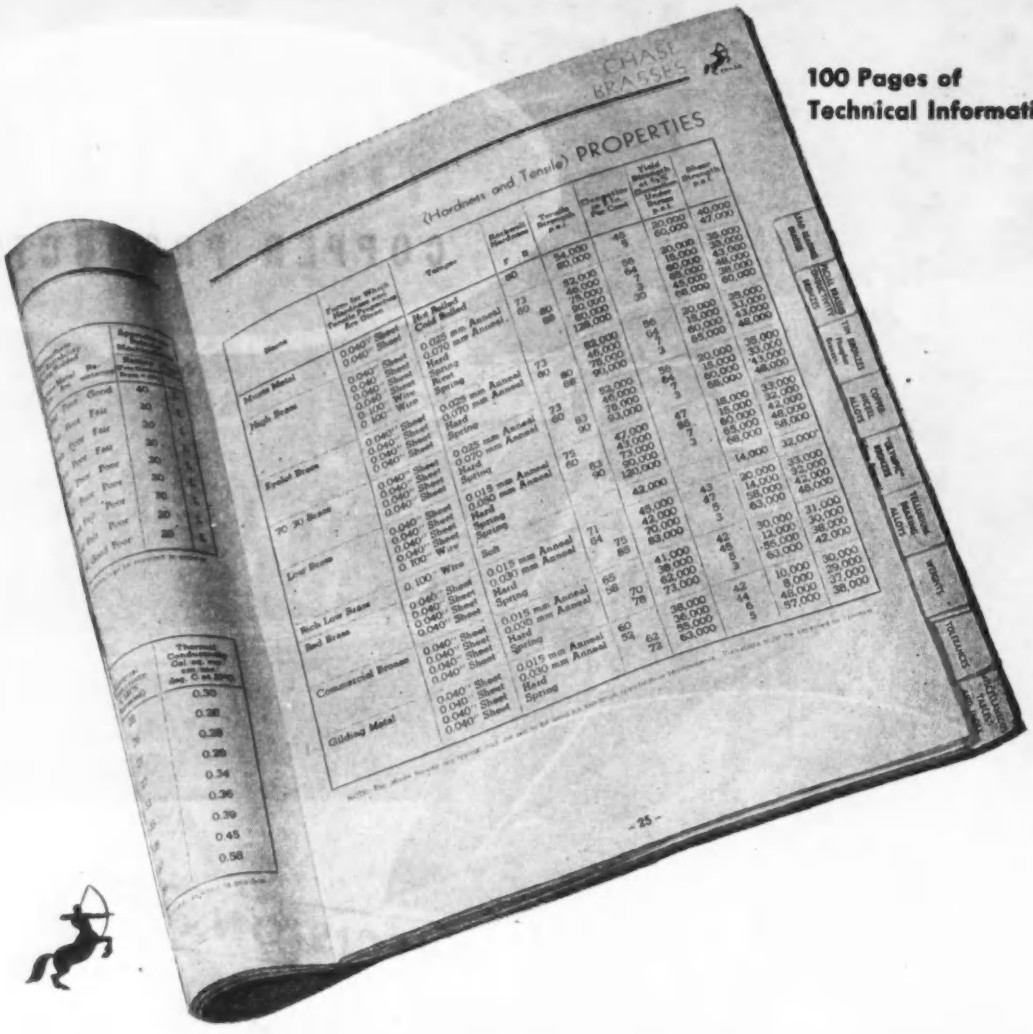

Data Book about the more Common and Useful Wrought Copper Alloys

If you are a product designer... if you specify or purchase brass and copper, you should have this informative manual. It can help you select more quickly, and secure more easily, any of the commercially important wrought copper alloys. For a complimentary copy of "Commercially Important Wrought Copper Alloys," write today on your letterhead to our Dept. PE-2

FOR EACH ALLOY THIS BOOK GIVES

The name most commonly used
(*with other names sometimes applied*)
The nominal composition
*Physical properties**
Mechanical and Working Properties
Typical Uses

*Such as tensile strength, elongation, hardness —given for a sufficient number of tempers to demonstrate the range of properties.

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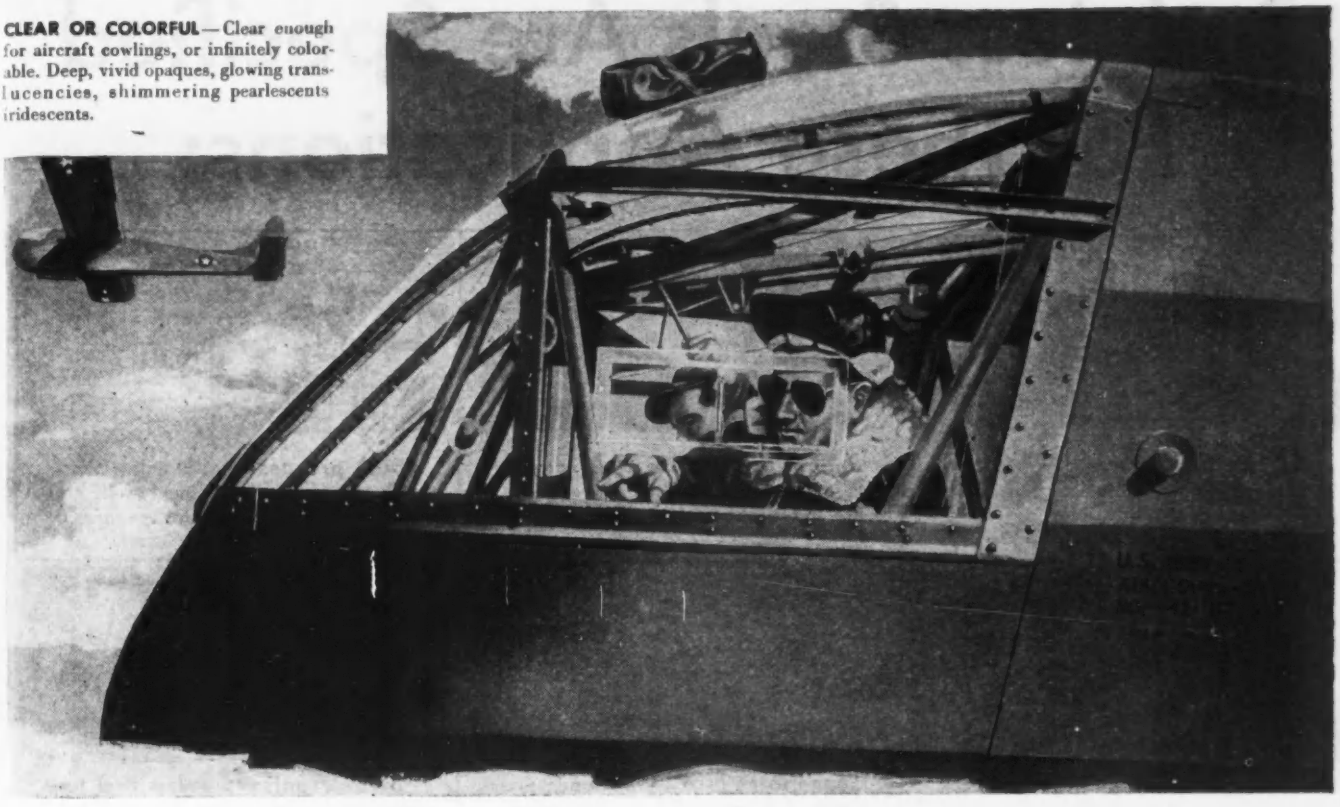
This is the Chase Network—handiest way to buy brass

CLEAR OR COLORFUL—Clear enough for aircraft cowlings, or infinitely colorable. Deep, vivid opaques, glowing translucencies, shimmering pearlescents iridescents.



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The cellulosics *combine more advantages* for a wider variety of uses than any other group of thermoplastics. In various forms and types they have continued, year after year, to get preferential selection for a vast diversity of products. Examples shown on this page are typical cases where a *combination* of important properties prompted the choice of cellulosics.

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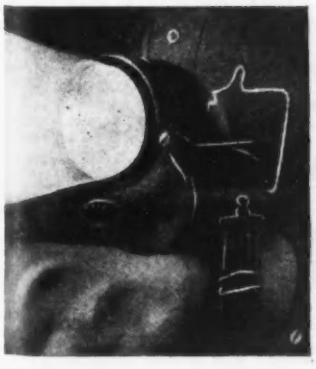
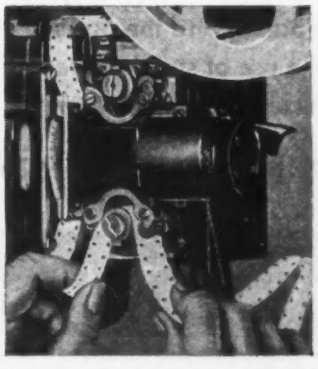
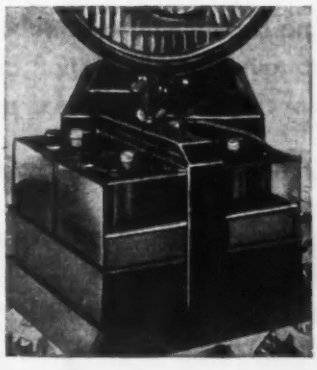


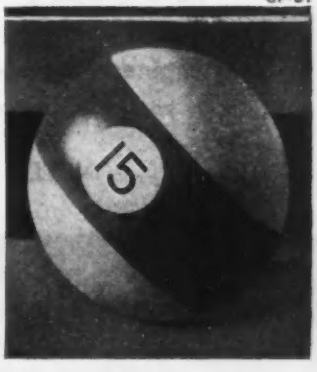
LIGHTWEIGHT—Cellulosics combine light weight with great strength, as in ping-pong balls, and countless other products where lightness and durability are essential.



FLEXIBLE OR RIGID—Cellulosics can be either hard and rigid—or flexible enough for movie film, wire insulation. Bend, twist, flex, or fold them!

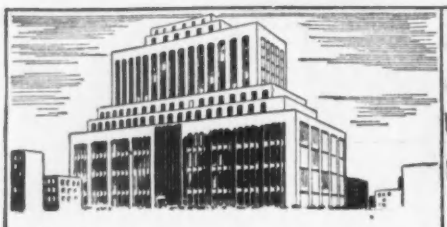


STABLE—Stable to climatic extremes of humidity and temperature, to many acids, alkalies, and alcohols, to gasoline, oils, and water.

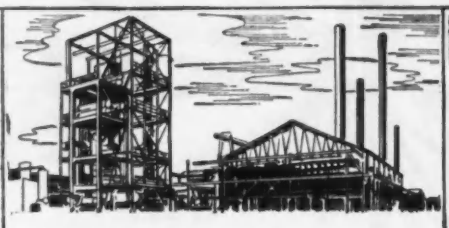


TOUGH—Cellulosics withstand constant wear, violent impact, crushing pressure; resist chipping, cracking, shattering, even at low temperature.

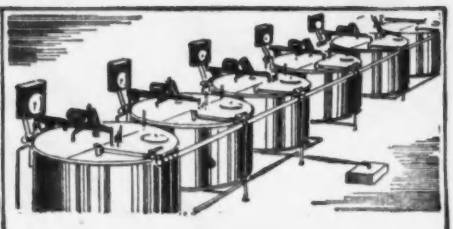
Stainless Steels Are Specified For These Applications:



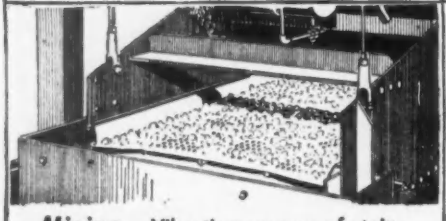
Architecture — For weatherproof exterior trim, stainless steel is not excelled in beauty or length of life.



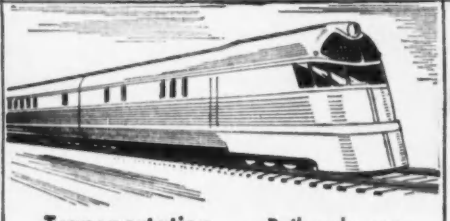
Refineries — Furnace tubes, carrying corrosive gases at high temperatures, are made of stainless steel.



Food processors — Stainless steel milk processing equipment will not taint milk and is easily kept sanitary.

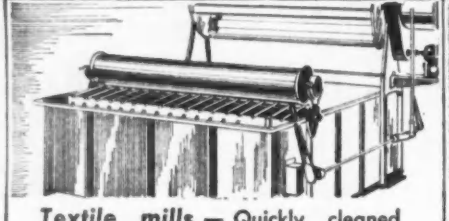


Mining — Vibrating screens of stainless steel resist abrasion and wear to give extra life.

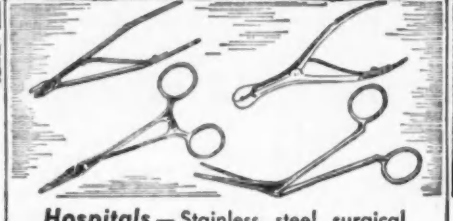


Transportation — Railroads use light-weight passenger equipment built of stainless steel.

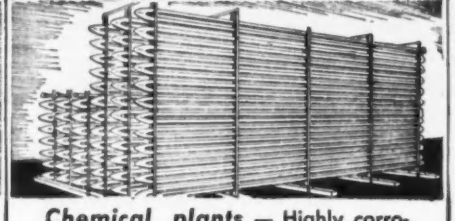
Power Plants — Stainless steel turbine blades resist corrosion and erosion of steam at high temperatures.



Textile mills — Quickly cleaned stainless steel dye vats make possible a rapid succession of dye baths.



Hospitals — Stainless steel surgical instruments resist corrosion from repeated high-temperature sterilization.



Chemical plants — Highly corrosive nitric acid is handled safely in a stainless steel condenser.

Have You Considered Using Stainless Steel?

• These are only some of the uses of stainless steel, but they may suggest how stainless steel can serve you. Although we do not make stainless steel or steel of any kind, we have had 38 years of experience in the manufacture of ferro-alloys used in the production of steel. Working closely with the steel companies and the users of stainless steel, our engineers have accumulated information on the use of stainless steel in many industries. If you want more specific details about a particular application, write to us.

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In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals

The word "Electromet" is a registered trade-mark of Electro Metallurgical Company

PROTECT AGAINST SPATTER WITH *Lionoil*

Urgent need to save valuable wartime hours and speed up production, leads to another important use for Berry Brothers' Lionoil! This newest time-and-cost-saving comes through the elimination of chipping or grinding off weld spatter.

A thin coat of Lionoil keeps spatter from sticking and eliminates need for costly, time-wasting clean-up.

Lionoil is the ideal material for this purpose. It is equally suitable for gas, electric or spot welding. It has no unpleasant odor and its use is highly economical. *It does not have to be removed.* You can weld right through it! *You can finish right over it!*

One user says, "The time and money we save by cutting out chipping and grinding, makes use of Lionoil practically mandatory."

Lionoil is also widely used to protect castings against rust — to eliminate sand blasting — make machining easier and cleaner — lengthen tool life — simplify cleaning to remove oil and grease before painting casting parts.

Order some Lionoil today for a spatter control test.

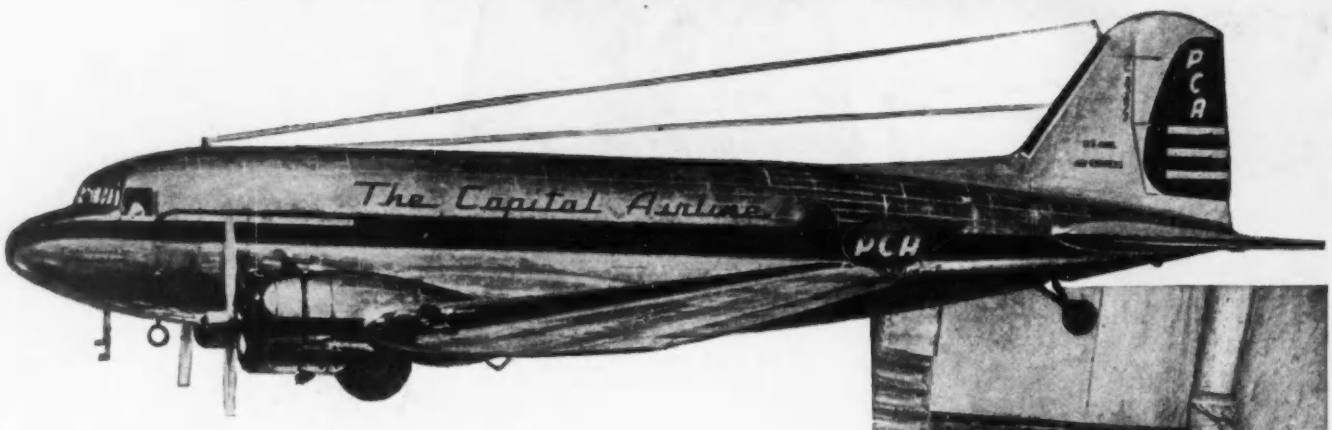
BERRY BROTHERS
Paints · Varnishes · Enamels · Lacquers
Detroit 7, Mich. Walkerville, Ont.

BOSTON • JERSEY CITY • CINCINNATI • CHICAGO
ST. LOUIS • INGLEWOOD, CALIF. • MONTREAL
WINNIPEG • TORONTO

SEE OUR INSERT IN SWEET'S NEW PRODUCT DESIGN FILE

QUALITY FINISHES SINCE 1858

CONTINENTAL'S NEW LAMINATED PLASTIC NOW ON ALL PCA PLANES!

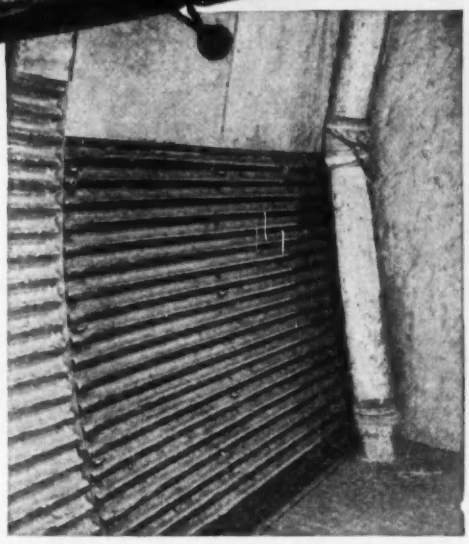


Six-month tests prove its superiority as cargo compartment liner, replacing aluminum

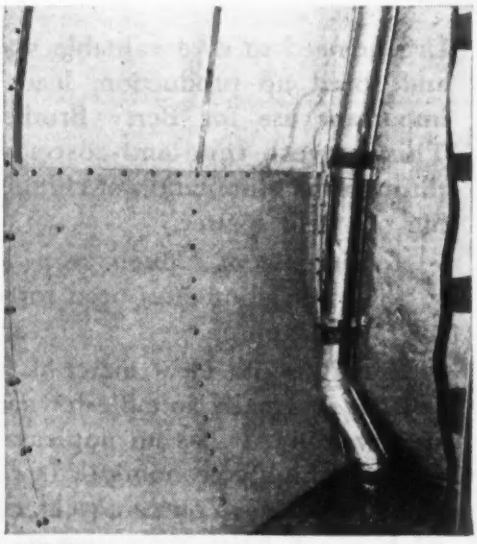
GOOD NEWS for designers and engineers! Some months ago cargo compartment linings made of Continental's new laminated plastic were experimentally installed in progressive Pennsylvania-Central's "Capital Liners." Here's what J. H. Carmichael, P.C.A. Vice President in Charge of Operations, has to say:

> *"The use of Continental laminated plastic as lining for our DC-3 baggage and cargo compartments has been extremely successful—so much so that we have adopted it as standard cargo compartment lining for our entire fleet and have highly recommended it to other airline operators.*
>
> *"Besides saving weight, this laminated plastic has brightened interiors considerably. And it replaces corrugated aluminum, which frequently punctured, leaving jagged edges that would tear bags and packages. After six months' service this new material has not punctured once—nor does it appear that it will in the future."*

This is only one example of the way designers and engineers all over the country are profiting from the experience and facilities of Continental's Plastics Division . . . an alert, progressive organization equipped to give sound, practical advice and assistance at all times!



BEFORE—Heavy corrugated aluminum cargo compartment linings punctured easily, left jagged edges that would tear baggage, reflected little light.



AFTER—Continental laminated plastic cargo bin linings save weight, have not punctured to date, brighten up interiors, making baggage labels easier to read.

CONTINENTAL CAN COMPANY, INC.

PLASTICS DIVISION

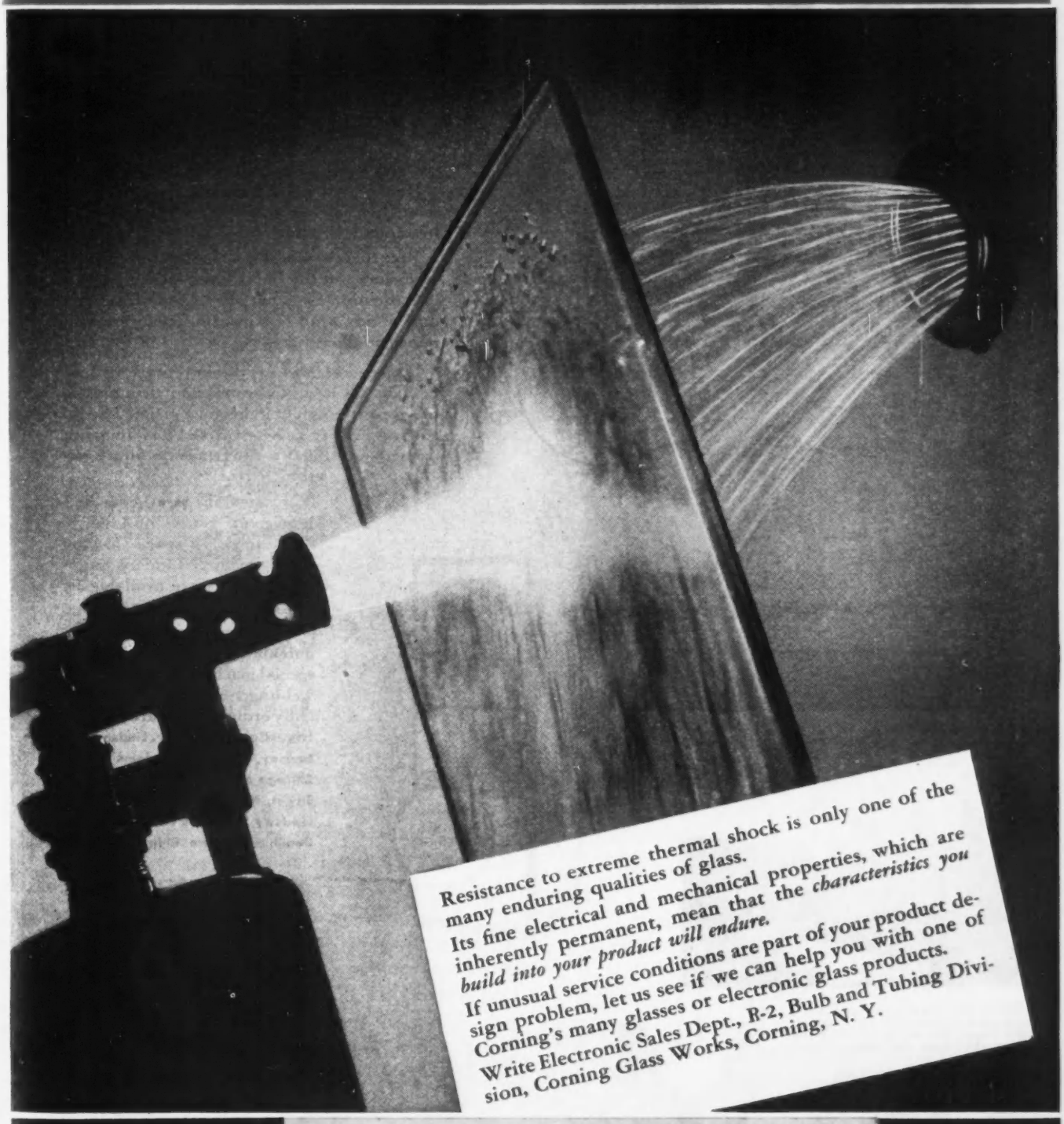
HEADQUARTERS: Cambridge, Ohio

Sales Representatives in all Principal Cities

COMPRESSION • INJECTION • EXTRUSION
SHEET FORMING • LAMINATION

OTHER PRODUCTS of Continental Can Company: Metal cans for food and other products; fibre and paper containers; crown caps and cork products; machinery and equipment.

GLASS ENDURES



Resistance to extreme thermal shock is only one of the many enduring qualities of glass.

Its fine electrical and mechanical properties, which are inherently permanent, mean that the *characteristics you build into your product will endure.*

If unusual service conditions are part of your product design problem, let us see if we can help you with one of Corning's many glasses or electronic glass products.

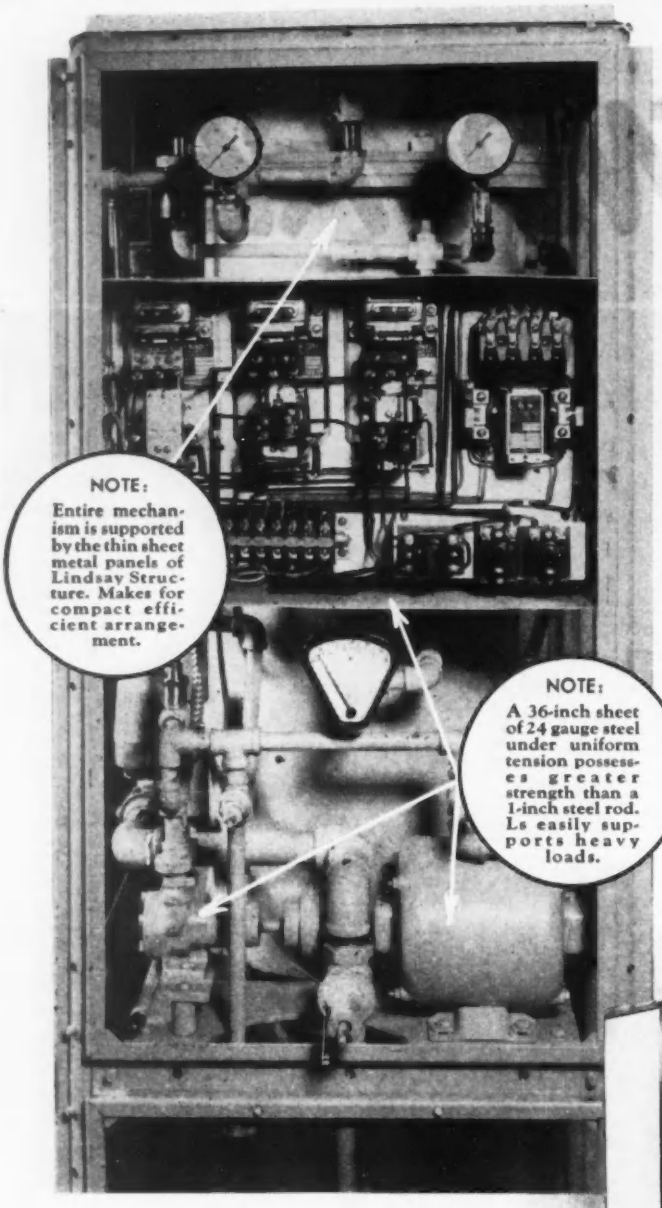
Write Electronic Sales Dept., R-2, Bulb and Tubing Division, Corning Glass Works, Corning, N. Y.

CORNING *means* Research in Glass

Electronic Glassware

TRADE MARK VYCOR REG. U.S. PAT. OFF. TRADE MARK CORNING REG. U.S. PAT. OFF. TRADE MARK PYREX REG. U.S. PAT. OFF.

"PYREX", "VYCOR" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.


NOTE:
Entire mechanism is supported by the thin sheet metal panels of Lindsay Structure. Makes for compact efficient arrangement.
NOTE:
A 36-inch sheet of 24 gauge steel under uniform tension possesses greater strength than a 1-inch steel rod. Ls easily supports heavy loads.

How to "SIMPLIFY and ADD LIGHTNESS"

to your new cabinet models and actually increase their strength

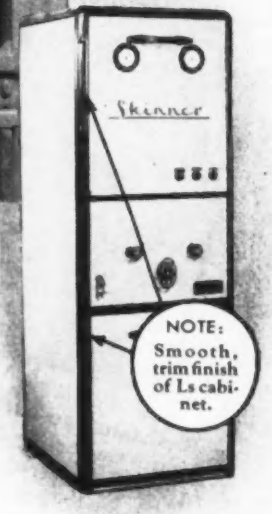
Here is an inside picture of a piece of equipment housed in—and completely supported by Lindsay Structure.

Note that the housing supports coils, switches, motors—all the heavy equipment that goes into the unit. No additional supporting structure of any kind is required. There are two important advantages:

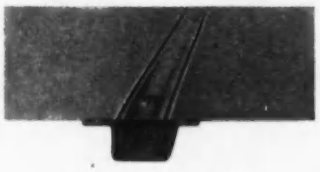
It saves weight. Ls is the improved method of light sheet steel construction that utilizes the great strength of light sheet metal. The resulting unit is light, and yet has amazing strength and rigidity—there are no flimsy rattling parts.

It saves space—the second important feature of Lindsay Structure. No space lost for superstructure. Lindsay Structure cabinets are available in any desired dimension.

Furthermore, you can tool up quickly for Ls production. No special machinery, no delay, no welding, no riveting, no waste. Only ordinary tools are needed. Investigate Ls today. **Lindsay and Lindsay, 222-B W. Adams Street, Chicago 6, Illinois; or 60 East 42nd Street, New York 17, New York; Lindsay Structure (Canada) Ltd., Dominion Square Bldg., Montreal.**



So strong and rigid is Ls that an I-beam, originally intended for support, actually sagged below this Ls housing even though it bore the added weight of four men.



Easy to assemble

LINDSAY STRUCTURE

U.S. Patents 2017629, 2263510, 2263511
U.S. and Foreign Patents and Patents Pending

MR. ENGINEER...66 years is a lot of leather

In 66 years of processing leather to protect and seal machine parts, Chicago Rawhide has solved again and again the toughest problems posed by the inventive genius of America's top industrial engineers. Three factors are responsible for the success of Sirvis leather products . . . the solid foundation of knowledge about mechanical leather which is Chicago Rawhide's greatest asset . . . the custom-built designs developed by research engineers who have learned that each new problem needs special consideration . . . and the rigid laboratory control in every stage of production, which insures absolutely uniform performance under all service conditions.

If protection is your problem, why not draw upon this unparalleled reservoir of specialized engineering experience? If your postwar designs include parts where irregular, eccentric or universal action makes a rigid seal impractical . . . a Sirvis leather boot may be the answer. If unusual precision, resilience, long service or resistance to pressure, shock, or vibration is demanded in packings, washers, gaskets, couplings or valve discs . . . Chicago Rawhide research can develop the properties you require, and careful production control can assure the most exact processing. For precision performance in protective coverings and seals, specify Sirvis mechanical leather.

sirvis

A Product of

CHICAGO RAWHIDE MANUFACTURING CO.

1305 Elston Avenue **Chicago 22, Illinois**

New York · Philadelphia · Detroit · Los Angeles · Cleveland · Boston
Pittsburgh · San Francisco · Cincinnati · Portland · Syracuse · Peoria

INVESTIGATE

"600" ALLOY
IT CONTAINS NO TIN

Preference Order M-43 prohibits the use of more than 2% of tin for many types of products. Wrought or Cast Bronzes needed for bearing or wearing surfaces require 5% or more of tin. "600" ALLOY contains no tin, but fulfills the same services. Its use, therefore . . . for many applications, nullifies any hardship which might result because of this limitation.

Bearings of "600" ALLOY, Gears, Pinions, Bushings, Spindles, and many other parts, have successfully replaced Phosphor Bronze applications, and at a substantial reduction in cost. "600" ALLOY weighs about 8% less than Phosphor Bronze and carries a lower base price.

In addition to bearing qualities, this alloy has excellent physical properties, corrosion resistance, ability to operate with scant lubrication and withstands abrasives better than most bearing alloys. The high strength of "600" ALLOY is often taken advantage of because it is possible to manufacture in one piece, a unit requiring the combined properties of two or more ordinary alloys.

"600" ALLOY is a FORGEABLE Bearing Metal which has a density and homogenity of structure, while Phosphor Bronze has a tendency towards porosity. "600" ALLOY will outwear stainless steels, nitrided steels and bronzes when operating in liquids containing abrasive materials such as grit or sand.

Samples of "600" ALLOY are available for test purposes. Write us if you have a bearing problem. "600" ALLOY may be the very solution.

MUELLER BRASS CO.
PORT HURON, MICHIGAN

TUNED TO TODAY'S PRODUCTION NEEDS

DURITE

P L A S T I C S

● **RESINS** . . . Phenol-Furfural and Phenol-Formaldehyde Resins. Other synthetic resins of many types for all purposes, including low pressure molding.

● **MOLDING COMPOUNDS** . . . Complete line of Phenol-Furfural and Phenol-Formaldehyde molding powders.

● **CEMENTS** . . . Bonds of remarkable strength for metal, wood and thermoset plastics. Cold-setting boil-proof plywood and wood bonds.

● **ADHESIVES** . . . Hot and cold-setting, for plywood, paper, glass, cloth and fibre; textile sizing and proofing; paper manufacturing, also, for wet strength and proofing purposes.

● **OIL SOLUBLE RESINS** . . . For production of air-drying or baking varnishes, protective coatings, and finishes.

● **WATER SOLUBLE RESINS** . . . For hot and cold molding, high and low pressure molding, and wet web impregnation.

● **NEW PROCESSES** . . . Dry impregnation, nozzleless injection molding, continuous thermosetting injection molding.

OUR EXPERIENCE IS AVAILABLE TO YOU

DURITE PLASTICS

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REPRESENTATIVES LOCATED AT:

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352 Plymouth Road, Union, New Jersey

245 W. Franklin St., Morrisville, Pa.

2711 Olive St., St. Louis 3, Mo.

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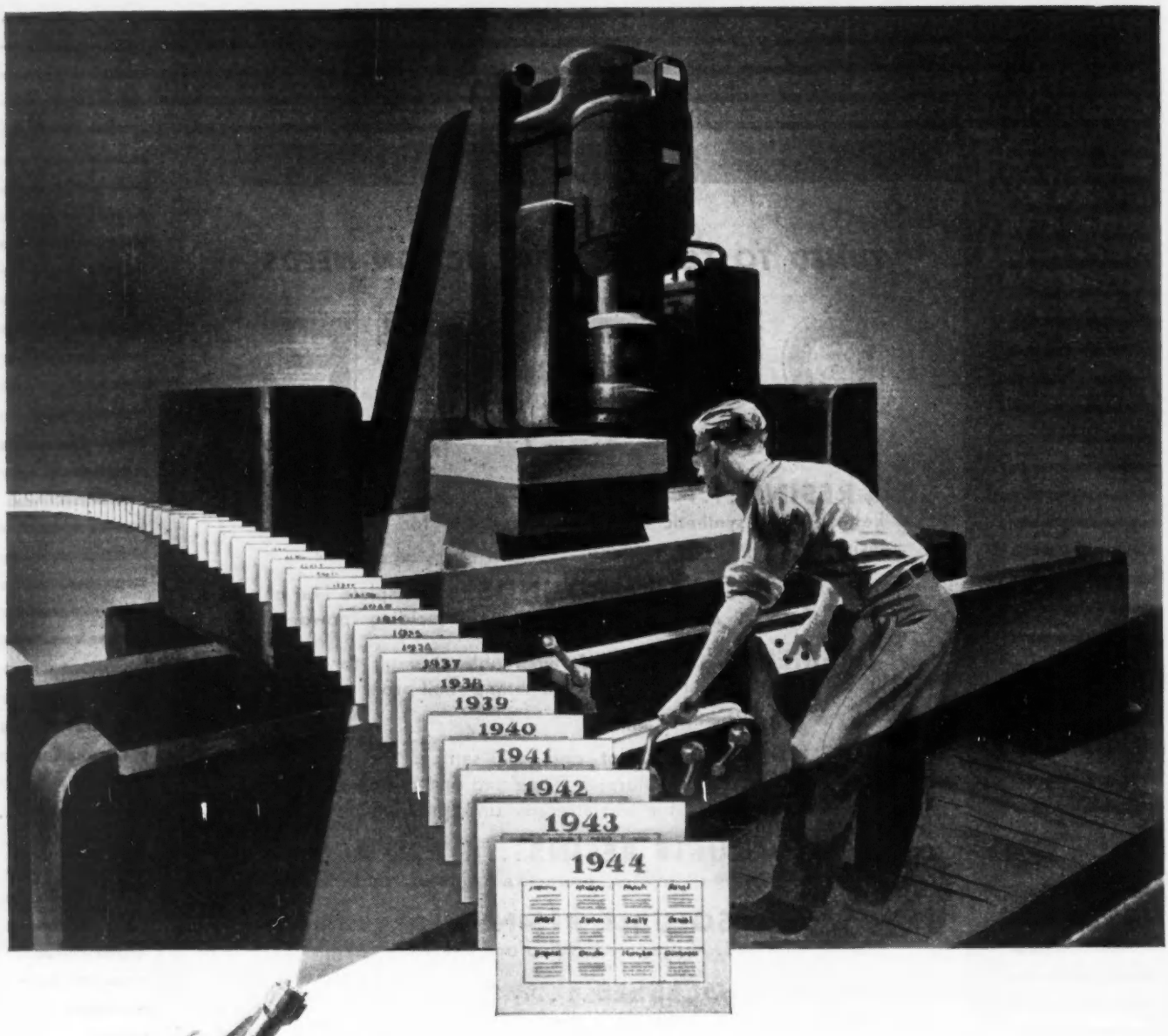


Design For Service To The Machine Tool Industry

(Beginning in 1929)

It is no accident that Lowe Brothers finishes have long been used by the majority of machine tool manufacturers. Here's the story!

Back in 1929, Lowe Brothers Finishing Experts went to The National Machine Tool Exhibition in Cleveland, to restore the finish on tools which were chipped or scarred in shipment. They have been doing it ever since!

In 1929, also, Lowe Brothers developed the machine tool color that was adopted by the Machine Tool Builders Association. It is still the standard of the industry.

It was Lowe Brothers, too, who helped break the bottleneck in machine tool production caused by the slow-drying varnish type of finishes. Lowe Brothers were one of the first to develop a complete lacquer finish. It reduced application time by two-thirds by the spray method, cut drying time of each coat from overnight to 15 minutes, and provided a finish which holds up under the constant action of cutting liquids.

Lowe Brothers finishes are the recognized standard of the machine tool industry. You can rely on Lowe Brothers broad experience with Government Specifications for machine tool finishes and industrial finishes of every type.

★ ★ ★

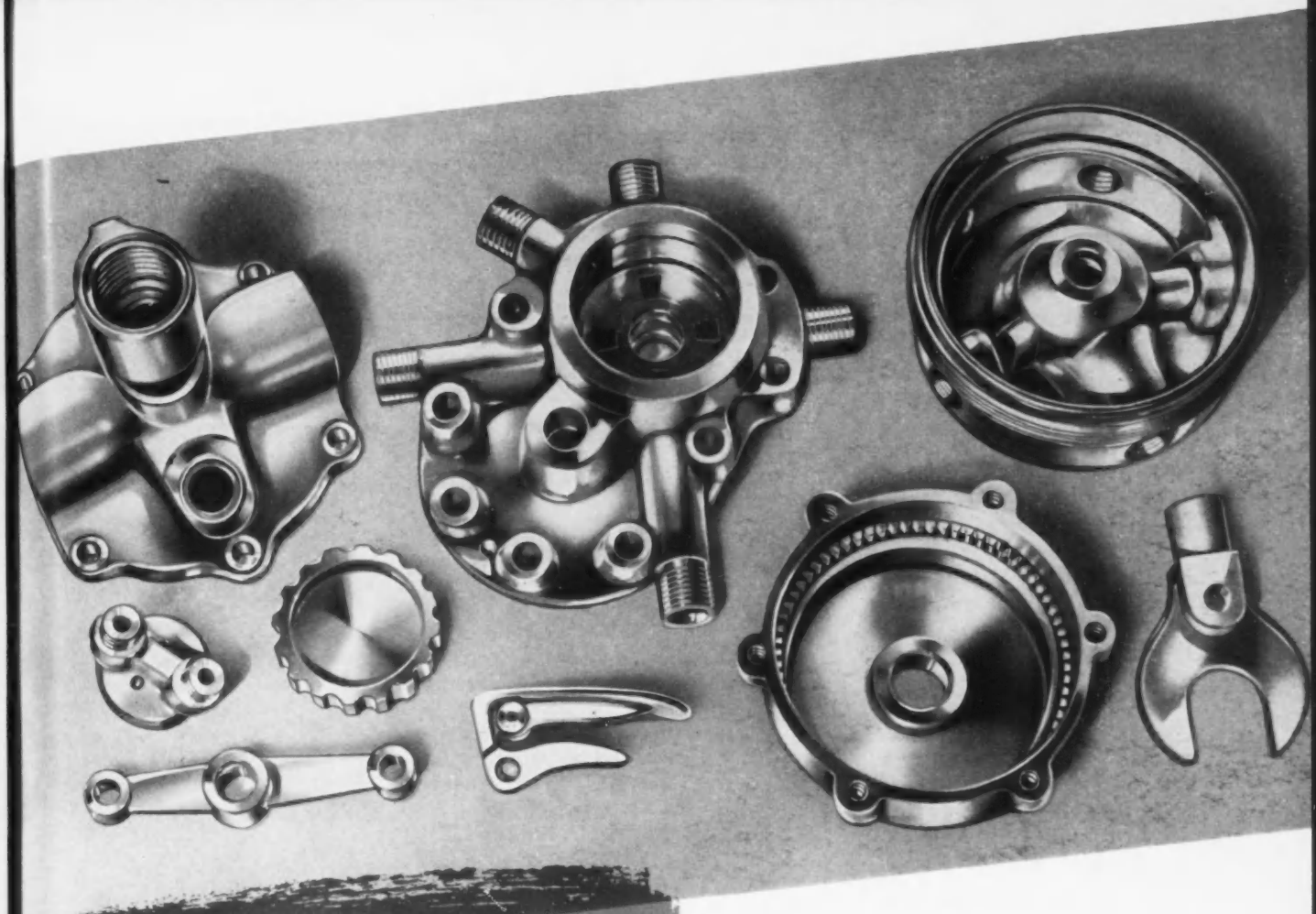
INDUSTRIAL SALES

THE LOWE BROTHERS COMPANY
DAYTON, OHIO

Lowe Brothers

WARTIME FINISHES *for Industry*

IN ACCORDANCE WITH U.S. GOVERNMENT SPECIFICATIONS



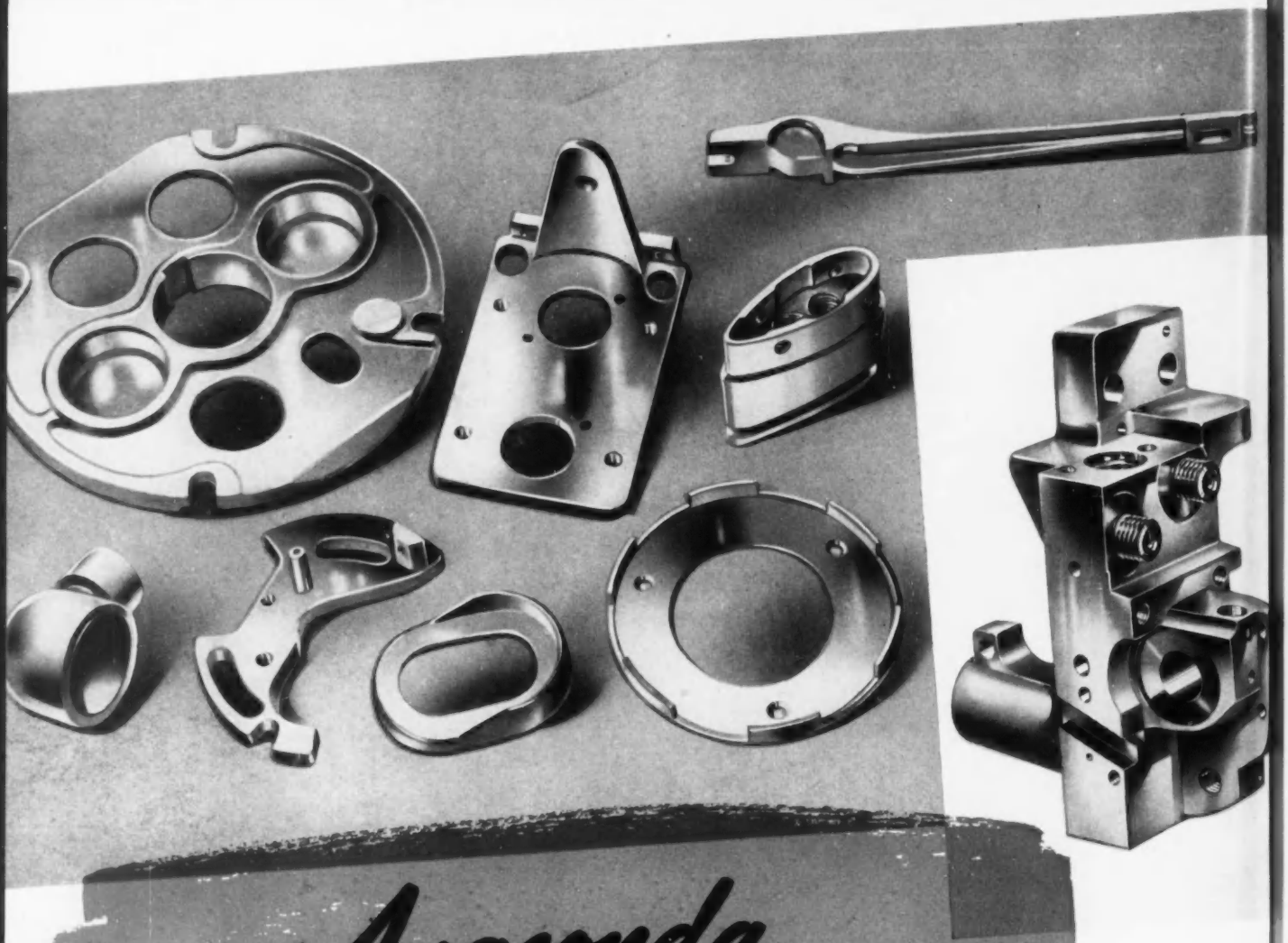
Anaconda HOT PRESSED FORGINGS

DOUBLE the strength of ordinary sand castings • Uniform, dense grain structure • Gas, air and water-tight • Require a minimum of finishing • No sand • Long tool life • Readily machinable • Consistent dimensional accuracy • Smooth, fine-textured finish • Available in Copper, Brass, Bronze and Special Copper Alloys

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY • Waterbury 88, Connecticut

Anaconda Pressure Die Castings are illustrated on the following page.



Anaconda PRESSURE DIE CASTINGS

POSSESS most of the advantages of other types of die castings—*plus* higher strength, higher resistance to impact, greater hardness and ductility, and a high degree of corrosion resistance • Adaptable to intricate coring and a wide range of design possibilities • Available in two Brass Alloys of 55,000 and 85,000 lb. per sq. in. tensile strength

If the use of a Pressure Die Casting (or Hot Pressed Forging as illustrated on the previous page) indicates a possible cost saving, an improved product or a production speed-up, our Technical Department will be glad to go into details.

ANACONDA
from mine to consumer

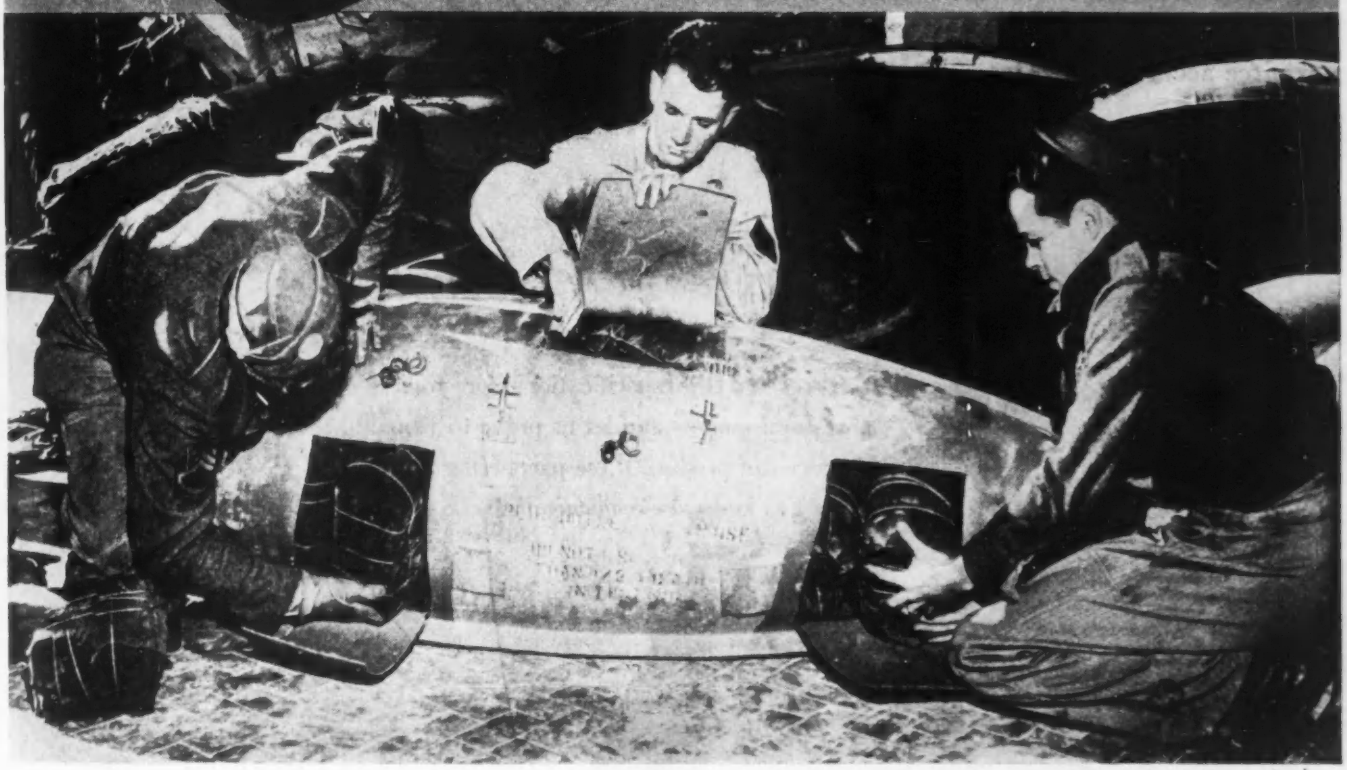
THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut • Subsidiary of Anaconda Copper Mining Company

In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

45155

"ORCO-BUILT" gas tanks serve as "SUPPLY BOMBS"



U. S. Signal Corps photograph

Variously known as "auxiliary," or "droppable," or "belly tanks" for aircraft, these ORCO-BUILT gas tanks serve as "SUPPLY BOMBS" too.

As shown in the photograph, supplies and equipment (instead of gasoline) are packed in the tanks and flown to U. S. Army paratroop infantrymen far behind enemy lines.

"Yankee Ingenuity" in Wartime

Still another use for ORCO-BUILT auxiliary tanks will be revealed at some future date. "Yankee ingenuity" invented this third use to make these harmless looking tanks a vital part of the final knockout of Berlin and Tokio.

"Yankee Ingenuity" in Peacetime

The big post-war problems to come can be solved if the same "Yankee ingenuity" now in action to win the war *stays in action after the war.*

We, here at ORCO, intend to keep "Yankee ingenuity" in action toward the constant development of our services and facilities in the field of rubber and synthetic rubber.

Now, and in the future, we invite your inquiries on specific problems.

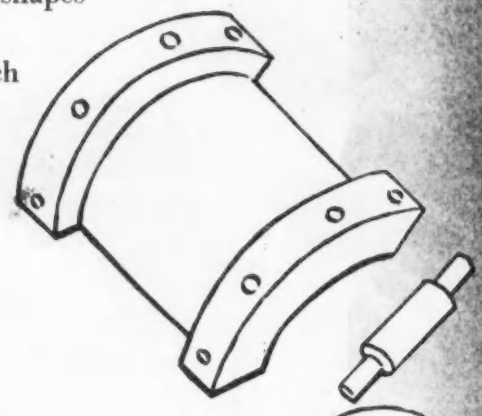
BRANCHES: DETROIT • NEW YORK • CHICAGO
INDIANAPOLIS • WASHINGTON • CLEVELAND

"ORCO-OPERATION"

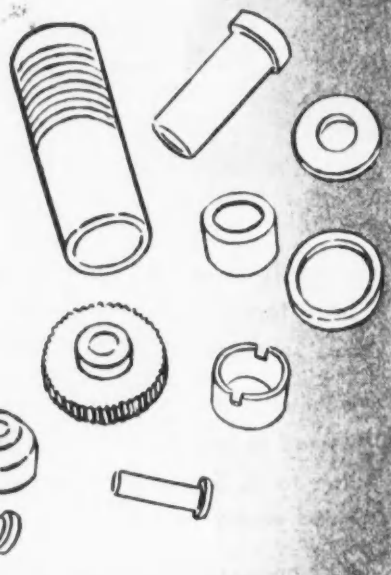
THE OHIO RUBBER COMPANY · WILLOUGHBY, OHIO

"... according to specifications"

Producing Machined Parts in large or small quantities is but one of our many specialized functions as specification fabricators. Here, in our modern plant skilled operators fashion many such parts of all sizes and shapes from many different materials on precision machines which guarantee accuracy to extremely close tolerances.



Send us the specifications for your *next* requirements and let us prove to you that we can produce these parts *better* . . . *faster* . . . and *more economically!*



Specification Fabricators of
VULCANIZED FIBRE, CORK, CORPRENE, PHENOL FIBRE, RUBBER, ASBESTOS AND OTHER MATERIALS

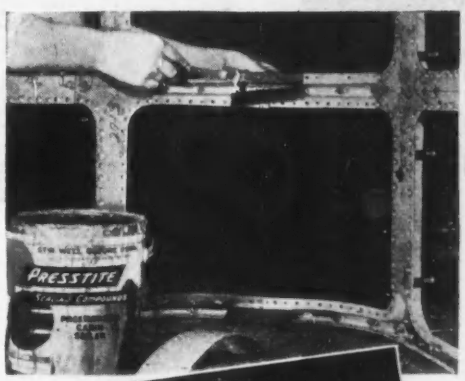
Branch Offices:
DETROIT: 4835 WOODWARD AVE. CHICAGO: 4317 RAVENSWOOD AVE.

Precision
FABRICATORS, INC.
EAST ROCHESTER, N. Y.

PRESSTITE Compounds Seal the Cabin on the Bell Jet-Propelled Airacomet!

The P-59 Airacomet in Flight

Applying Presstite Cabin Sealer to Hatch of the Bell P-59



Applying Presstite Synthetic Glass Sealer to Windshield of Bell P-63. Photos, Courtesy Bell Aircraft Corp.

To assure air and water tightness in the cabin compartment of both the Bell P-59 jet-propelled Airacomet and the Bell P-63 Kingcobra, Presstite No. 11544 Cabin Sealer and Presstite No. 23212 Synthetic Glass Sealer Compounds are used. Large quantities of these and other Presstite Sealing Compounds are also used in the construction of the Bell-built, Boeing-designed, B-29 Superfortress.

Thus another famous aircraft builder joins the many who rely on Presstite sealing compounds for many vital uses which include the sealing of fuselage seams, gun turrets, fuel tanks, seaplane floats, etc.

To industry at large, Presstite offers the same engineering skills and technical knowledge that led to the development and manufacture of such compounds as those mentioned above. Thoroughly proven in both war and peace, Presstite Sealing Compounds are the result of highly specialized experience in the whole sealing field.

Whatever your own sealing problem may be, or your need for coatings and adhesives, call on Presstite's knowledge. We'll gladly work with you right now on *any* sealing requirement.

PRESSTITE
SEALING COMPOUNDS

PRESSTITE ENGINEERING COMPANY, 3956 Chouteau Avenue, St. Louis 10, Missouri

A Partial List of Industries for Which Presstite has successfully Developed Special Sealing Compounds:

For the Aircraft Industry:
Sealers for
- Integral Fuel Tanks
- Fuselage Seams
- Drop-off, Expendable Fuel Tanks
- Gun Turrets
- Synthetic Glass
- Instruments
- Intercoolers
- Air Ducts
- Insulating Dissimilar Metals
- Seaplane Floats

For the Refrigeration Industry:
Sealers for Domestic and Commercial Refrigerators
Bonding and Sealing Low Temperature Insulation in Refrigerated Rooms

For the Railroads:
Sealers for Insulating, Soundproofing and Weatherproofing of Railway Cars—Sealing Car Windows and Spot Welded Seams

For the Building Industry:
Roof Coatings, Caulking, and Waterproofing Compounds

For the Radio Industry:
Sealers for radio panels and cases, coil impregnation — many communication equipment applications.

For the Automotive Industry:
Special Adhesives and Sealers

For the Construction Industry:
Sealers for Jointing Sewer Pipes
Sealers for Waterproofing Excavation Work

Miscellaneous:
- For Glazing Greenhouse Windows
- Extruded Caulking Compounds
- Ammunition Paints
- Plus Many Special Products for the Army and Navy

Our Engineering, Technical, and Laboratory facilities are at the service of any industry with a sealing problem.

Blackout For Exhaust Flames!

Burning exhaust gases no longer "spot" night-flying planes for enemy observers . . . thanks to the Solar flame damper which suppresses the tell-tale flames, reduces plane visibility and has greatly increased the effectiveness of night combat operations.

Solar engineers have played a major part in the development of flame dampers because the design and fabrication of products which must withstand high operating temperatures and severe vibrations, possess great structural strength, yet be light in weight, has been Solar's specialized activity for fifteen years.

As the leading manufacturer of airplane exhaust systems and other high temperature alloy products for the elimination of gases, the utilization of waste heat energy, and the control and transfer of heat, Solar has become the recognized authority. Its services are available to design engineers with such problems.

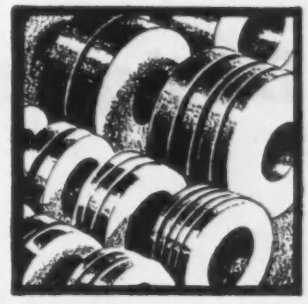
ARMY ★ E ★ ★ NAVY ARMY E NAVY

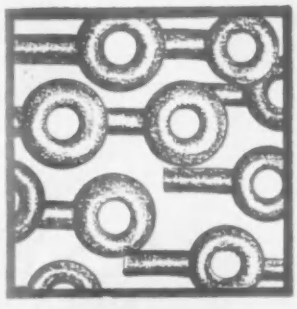
SOLAR

STAINLESS STEEL PRODUCTS

SOLAR AIRCRAFT COMPANY ★ SAN DIEGO 12, CALIF. ★ DES MOINES 5,

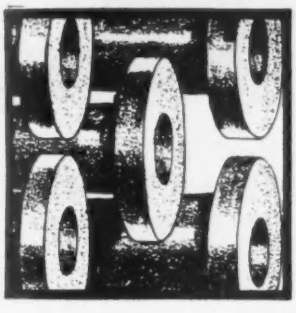
How Kropp Can Help You in Your Postwar Forgings Requirements



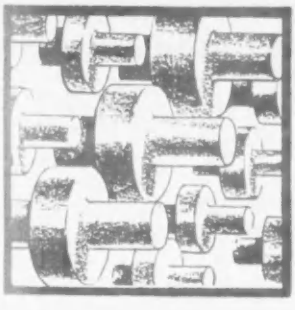


The service offered by the "world's largest job forging shop" has been definitely broadened during the past four years.

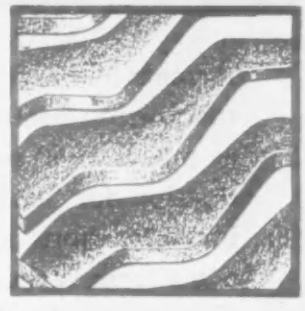
Facilities and capacity have been tremendously expanded. New techniques of far reaching importance have been developed at Kropp Forge to meet urgent war production needs. The making of "drop forgings" on flat die hammers (at a time when 24-hour-a-day operation of drop hammers was not enough) is only one of these. Many "impossible" forgings have been turned out at Kropp Forge when the war machine required them. Some of these Kropp developments will continue to provide important economies and other advantages for peacetime users of forgings. The experience of over a century, amplified during recent years, gives us ample "know how" in all matters of forgings production.

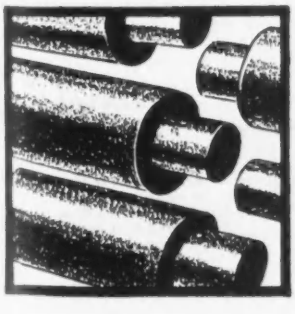


Wartime lessons are being reflected in postwar machines and equipment. The broader use of forgings had much to do with the ruggedness and superior performance of American-built planes, tanks, military vehicles and other fighting units. Naturally, designers of the machines of tomorrow are planning a more extensive use of forgings, which provide metals at their ultimate strength as well as savings in weight, space and machining time.

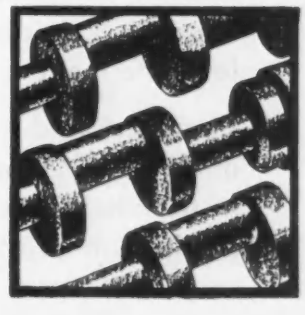


Reconversion has for some time been under way at Kropp Forge. As war tasks are completed, capacity is becoming available for the production of flat die, drop and upset forgings for permissible applications.





Call the nearest Kropp engineering representative. He is shop-trained and can give you practical help on your requirements and problems. If you prefer, send your blueprints with details direct for immediate quotation.



KROPP FORGE COMPANY

5301 W. Roosevelt Road Chicago (50), Illinois

Engineering Representatives in Principal Cities

Design that part in ArmaSteel*

Step Up Output . . . Cut Down on "Chips" in Your Manufacturing Operations

ArmaSteel, cast close to finished dimensions, cuts machining requirements and machining man-hours as much as 50 per cent . . . substitutes profitable production for "chip" production. And besides speeding operations and reducing costs, ArmaSteel offers a uniform structure of great strength and high resistance to shock and stress. Its maximum endurance, high rigidity, excellent machining qualities and long life make it ideal for critically stressed parts.

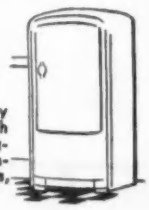
Engineers and designers are invited to compare the qualities of ArmaSteel with the qualities they seek in the vital parts of their own products, both for war production and for peacetime use.

See How ArmaSteel Speeds Production of Vital Parts

TRANSMISSION PARTS

Comparative figures indicate part of the saving effected by ArmaSteel: Weight of forging formerly used, 8-2/10 lb.; weight of ArmaSteel rough casting, 5-7/10 lb.; weight of finished part, 3-3/10 lb.

HOUSEHOLD APPLIANCE INDUSTRY

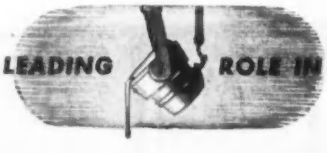


ArmaSteel is used for many parts requiring high strength and wear-resistance—refrigerator compressor unit connecting rods and crankshafts, for instance.

UNIVERSAL JOINT YOKES

ArmaSteel reduced broach load from 11,000 to 5,500 lb., stopped tool chatter, cut tool costs.

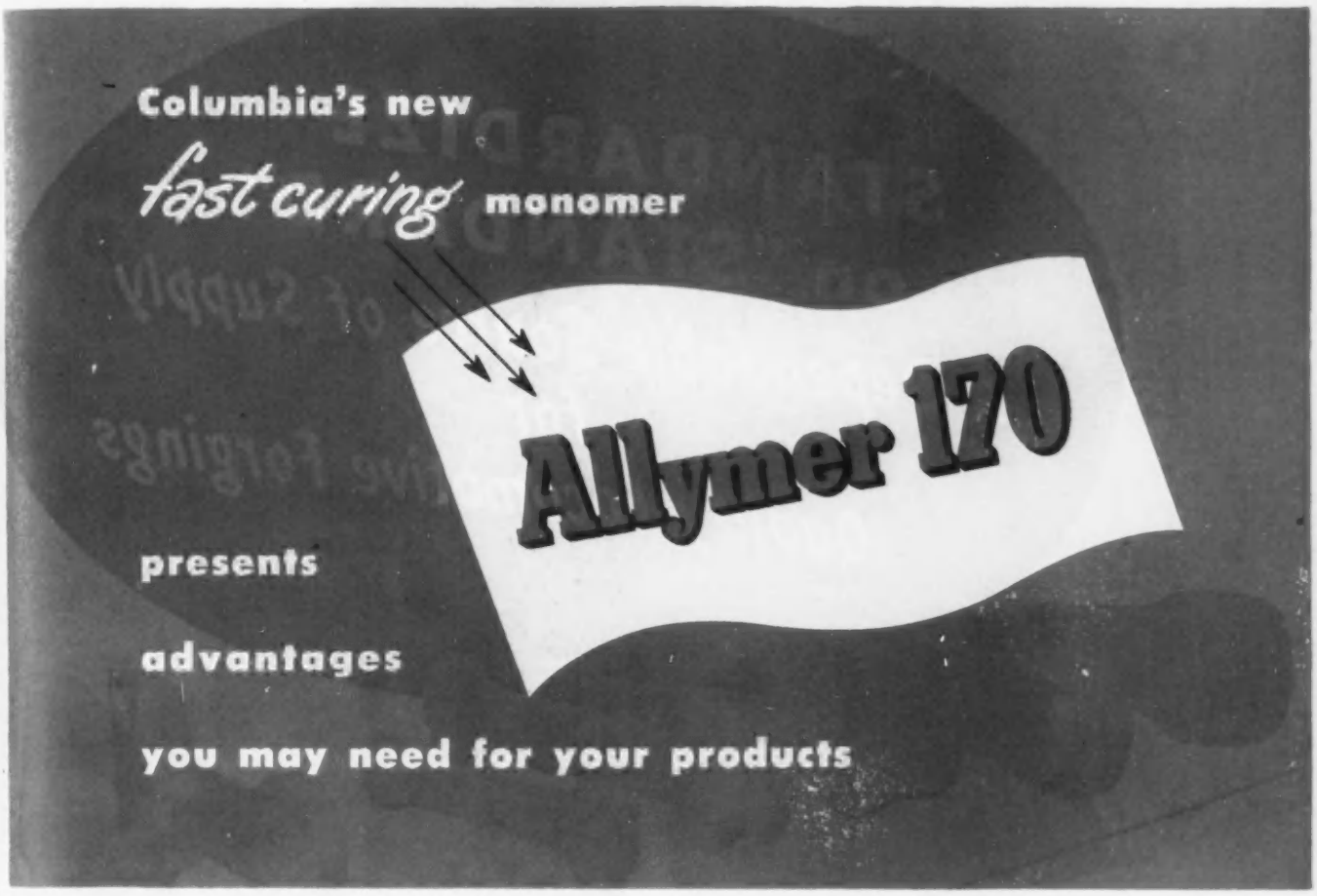
It is entirely possible that ArmaSteel can effect similar savings and improvements in your plant's processes and products. We suggest that you write us, detailing your requirements.

CAST FOR A LEADING  ROLE IN INDUSTRY

Let's See It Through
BUY MORE BONDS

SAGINAW MALLEABLE IRON DIVISION OF GENERAL MOTORS
SAGINAW, MICHIGAN

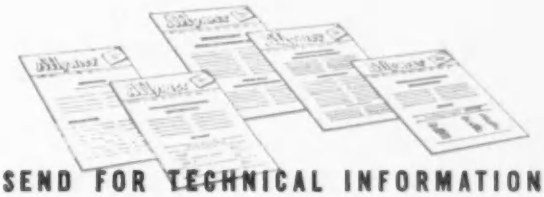
*Reg. U. S. Pat. Off



The newest of the new Allymers—Columbia thermosetting, contact-pressure allyl resin monomers—is Allymer 170. Developed especially for processes requiring relatively fast cures, Allymer 170 also possesses numerous other desirable characteristics in a combination unique in the plastics field.

Allymer 170 is a viscous liquid of low volatility which solidifies into a hard, insoluble, infusible, clear solid when heated in the presence of a peroxide catalyst. It has practically no odor at room temperature, is non-irritating to the skin, evolves no gaseous or other by-products during polymerization. It may be stored for relatively long periods at room temperature without undergoing appreciable change.

Allymer 170 may be used for casting colored and opaque sheets, rods or other objects and is particularly suitable for impregnated and laminated products at contact pressures. Strength is an outstanding characteristic—Allymer 170-Exeter Print Cloth laminates, for example, test up to 92 Rockwell Hardness . . . 12,500 psi. tensile strength at 25°C. . . . 18,600 psi. flexural strength at 25°C.



SEND FOR TECHNICAL INFORMATION

If these properties and characteristics of Allymer 170 suggest uses for your products, write for more complete data. Samples may also be obtained for experimental purposes.

COLUMBIA CHEMICALS

PITTSBURGH PLATE GLASS COMPANY
COLUMBIA CHEMICAL DIVISION
GRANT BUILDING · PITTSBURGH 19, PA.

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Whenever you need *higher* quality locomotive forgings in steel of practically any chemical composition or specification — standardize on "Standard".

Standard has been serving the railroads since the first mile of track was laid, knows railroad problems—and how to produce the material to meet them. The Baldwin Locomotive Works, Philadelphia, Penna. Offices: Philadelphia, New York, Washington, Boston, Cleveland, Chicago, St. Louis, Houston, San Francisco.

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ARMY NAVY

BLW THE BALDWIN GROUP

BALDWIN
STANDARD
STEEL FORGINGS & CASTINGS

Are you looking into "new" materials?

This booklet

may help you solve a problem!

If you want information on modern industrial glass, this booklet will be useful to you, and may suggest a means of improving your products or reducing your costs.

Glass is, of course, *not* a new material—in fact it is one of our oldest. However, recent advances in glass technology have endowed it with new and improved properties, thus enabling design engineers to use glass to considerable advantage in a wide variety of applications.

We will be glad to send you a copy of this imagination-stimulating publication. The material it contains is based upon extensive experience in the manufacture and application of glass products. Send for your copy now!

KOPP GLASS, Inc.

SWISSVALE, PA.

Please send me a copy of LOOKING AT ENGINEERING PROBLEMS THROUGH GLASS.

Name _____

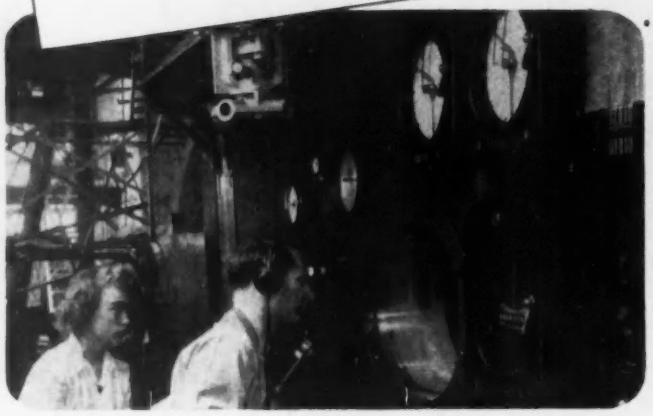
Position _____

Company _____

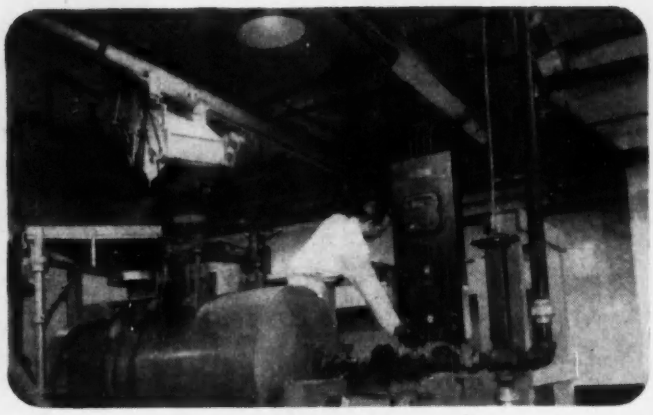
Address _____

What's your problem?

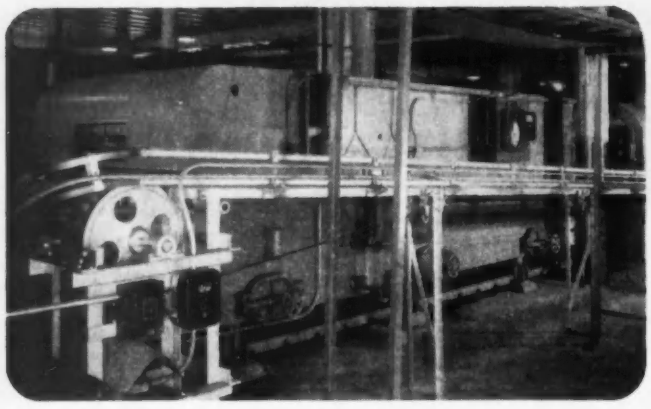
1. More and more manufacturers are solving their problems by selling their machines Taylor-equipped! For 3 reasons: (1) Optimum performance can be assured, often with simpler instrumentation, by seeing Taylor during the blueprint stage. (2) Equipment can be *kept* at top operating efficiency by our nation-wide organization of Field Engineers and branch-plant repair service. (3) Taylor's 94-year-old name and reputation has real promotional value.



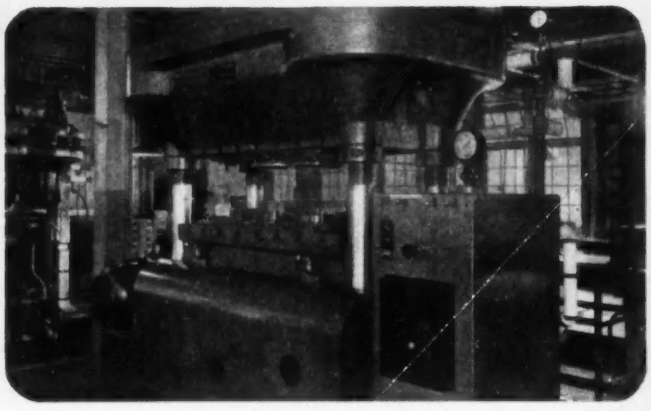
2. Probably you'll never build an altitude chamber, but you may gain something from this one at Curtiss-Wright, where the problem was to bring the temperature in the chamber quickly down to −67°F. We solved it with standard Taylor Fulscope Controllers. We can help *you* control anything from an ice plant to an air conditioning system.



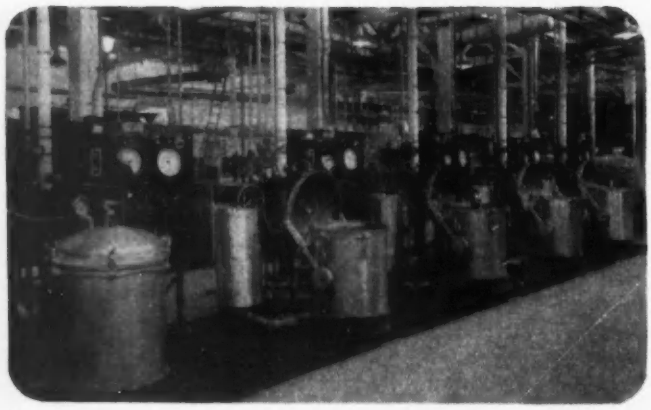
3. Here's an interesting example of completely automatic control. All the operator of the Pfaudler Steam Peeler has to do is load the vessel and push the button. Taylor Controls do the rest. We've been supplying all branches of the food and canning industries with temperature and pressure controls since the beginning of scientific food processing.



4. In the milk industry, in carbonated beverages, in brewing, Taylor instruments are on the job to protect flavor and uniformity. For example, this pasteurizing unit manufactured by The Heil Co. is standard with Taylor Instruments. Once the ideal temperature schedule is determined the Taylor Fulscopes reproduce it exactly time and time again.



5. Planning a plastics molding press? Why not find out if Taylor can help you make it better by instrumentation? Photo shows one of the latest developments in plastics molding presses—a new toggle action type. It's automatically controlled by a Taylor Flex-O-Timer, one of the most versatile, flexible process-timing instruments ever made.



6. On almost any piece of processing equipment, the right Taylor Instrument can cut operating costs by eliminating waste. This shows the Taylor Coordinated Control System for completely automatic operation of Venango Package Dye Machines. None of these photos may show *your* problem—but chances are we can help you solve it.

ARMY E NAVY

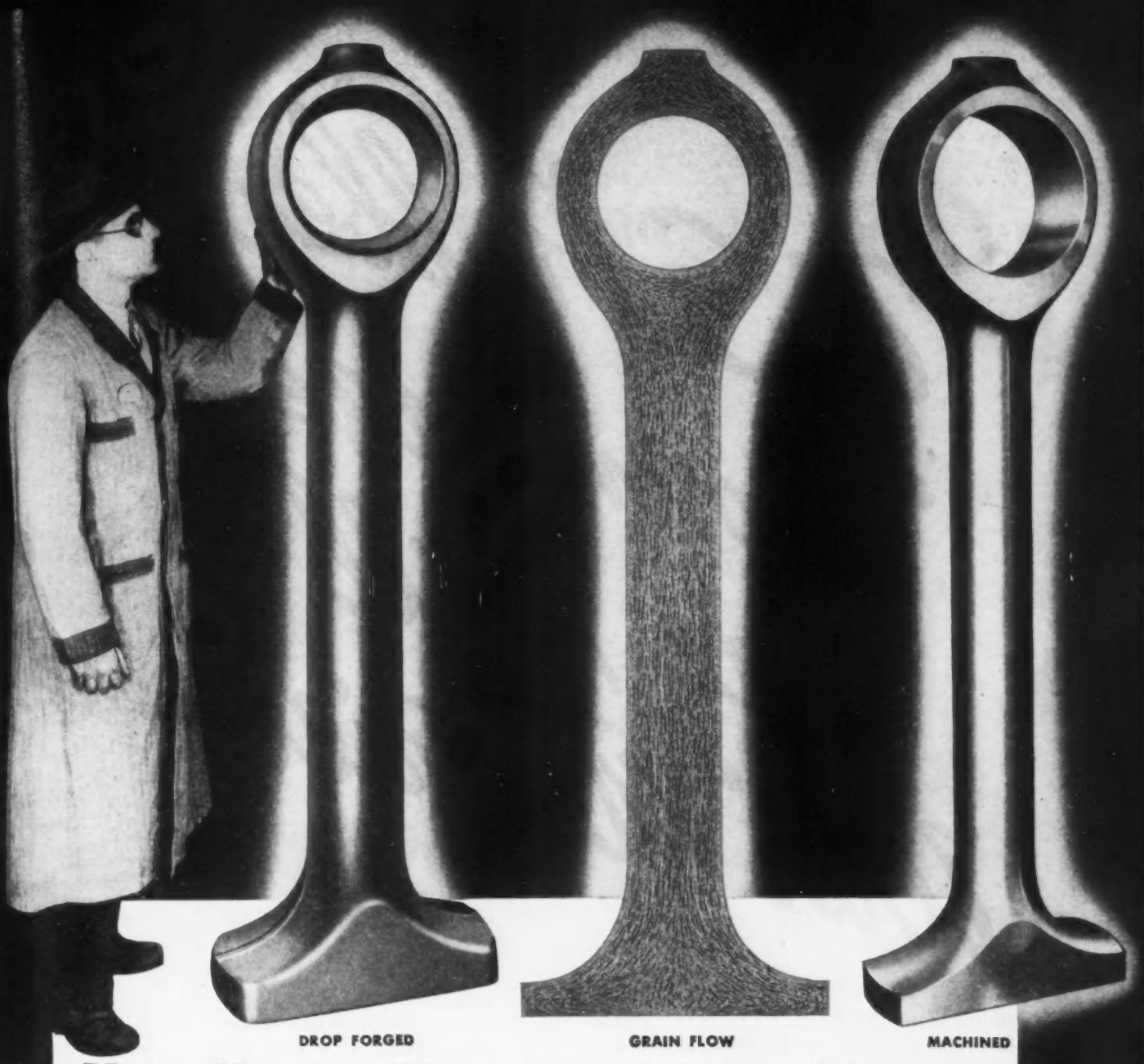
Taylor Instruments

MEAN

ACCURACY FIRST

IN HOME AND INDUSTRY

7. If there's a chance instrumentation can help your postwar product, be sure to call Taylor before your planning gets beyond the blueprint stage. It may save a lot of trouble and expense later on. Taylor Instrument Companies, Rochester and Toronto. *Instruments for indicating, recording, and controlling temperature, pressure, humidity, flow and liquid level.*



DROP FORGED GRAIN FLOW MACHINED

New Heavy Drop Forging Techniques

give designers greater latitude

Higher speeds—increased horsepower at no added weight—require higher physical properties...which can be obtained in drop forgings.

Ladish engineers are available now for consultation on your post-war products.

DROP FORGINGS
UP TO
2500 LBS.

TO MARK PROGRESS

ARMY E NAVY

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CUDAHY • WISCONSIN

U.S. Rubber Mountings are still War Materiel...

Nothing would please us more than to work with you on problems of eliminating vibration in post war equipment. But until the date of final supremacy for American arms is clearly at hand, commercial and domestic requests for U. S. Rubber Mountings must be subordinated to those directly involved in the war effort.

Right now, United States Rubber Company technicians are completely occupied with demands from the Army, Navy and Air Forces. New weapons—as well as new implements for communication and control—call for scientific protection against vibration and shock. And the proving-ground of mechanized warfare has shown that such protection is best provided by the use of rubber insulators.

Moreover, in plants directly concerned with turning out this materiel, engineered rubber mountings are no less essential. They help speed production; lengthen the life of critical machines.

You will find, however, when we are again free to serve you that "the new science of smoothness" has progressed enormously in recent years and months. War has taught our engineers and chemists much about rubber—the greatest and most useful of all the plastics.

SERVING THROUGH SCIENCE

Listen to "Science Looks Forward"— new series of talks by the great scientists of America — on the Philharmonic Symphony program. CBS network, Sunday afternoon 3:00 to 4:30 E.W.T.

UNITED STATES RUBBER COMPANY

1230 Sixth Avenue • Rockefeller Center • New York 20, N. Y. • *In Canada:* **Dominion Rubber Co., Ltd.**

PRESCRIPTION for Resin Troubles

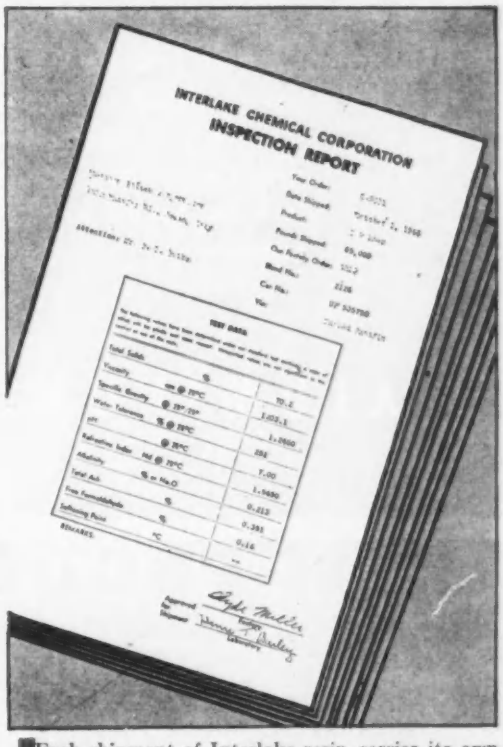
Rx Specificity plus Exacting Laboratory Control at Source

RESINS *not* specifically developed for individual applications, and resins which vary appreciably (from one shipment to another) in chemical or molecular characteristics, are the common causes of users' resin troubles.

But—when a resin is scientifically prepared for only *one* specific application, *job tested*, and its production stabilized—*then* dependable uniformity in satisfactory performance is achieved. Interlake has proved this for large industrial users.

Interlake *specializes* in the development of resins for specific applications and so *stabilizes* production of each specification resin that the performance of *every* shipment delivered is identical with the first.

The extremely close range of variation within which Interlake Resins are held is evidenced by a control laboratory inspection report—*with each shipment*—showing the complete chemical characteristics of the resin.



Each shipment of Interlake resin carries its own analytic inspection report from the Interlake Control Laboratory. Thus you can be sure of the *uniformity in performance* of the shipment you receive today—or a year from today. No other supplier provides this exacting evidence of production control.

Interlake Production-Stabilized Resins have been developed to precise requirements of specific applications in coating, impregnating, bonding of . . .

WOOD • PAPER • METAL • GLASS • FIBRE • RUBBER • CELLULOSE • ETC.

IF YOU HAVE A RESIN PROBLEM draw freely upon the wide experience of Interlake. We will gladly work with you on any resin problem, or discuss with you the possible advantage of using resins in any operation or process. Write Interlake Chemical Corporation, Plastics Division*, Dept. 60, Union Commerce Building, Cleveland 14, Ohio.

Specificity in RESINS

INTERLAKE CHEMICAL CORPORATION, Plastics Division*

**Formerly Central Process Corporation*

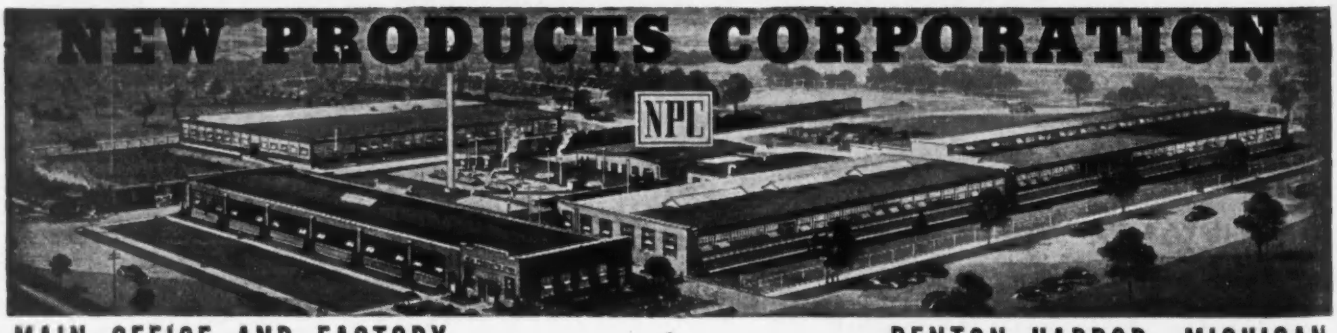
NOT *Difficult* YOU SAY!

No Bugs? Note the deep recess in this casting. The unusual job is a New Products specialty.

No High Pressure Die Casting job is too tough — *if* you use the right die design, *if* cast under proper operating conditions, and *if* produced under the constant, rigid scientific control exercised by New Products. Small quantities or mass volume production runs are laboratory-tested from start to finish. Submit your problems to our staff for process-material-production analysis in:

ALUMINUM • MAGNESIUM • ZINC

NEW PRODUCTS CORPORATION

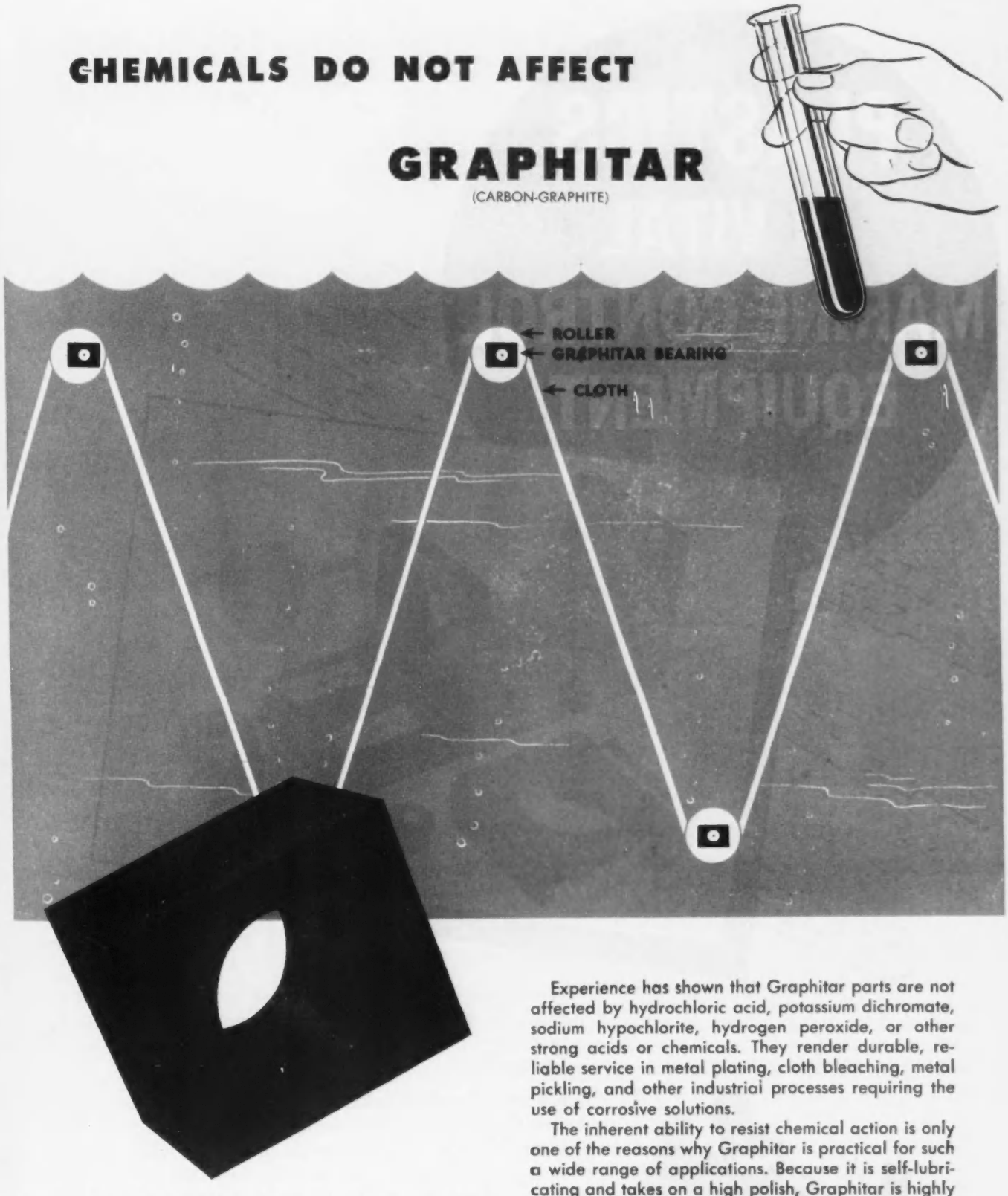


MAIN OFFICE AND FACTORY • BENTON HARBOR, MICHIGAN

CHEMICALS DO NOT AFFECT

GRAPHITAR

(CARBON-GRAPHITE)



Because it is chemically inert, Graphitar, a product of the United States Graphite Co., has proven to be the ideal material for bearings, bushings and other parts which must withstand chemical attack. A typical application is illustrated above in the sketch of a dye vat in which Graphitar bearings, although completely submerged in corrosive dye, assure continued smooth operation to cloth-carrying rollers.

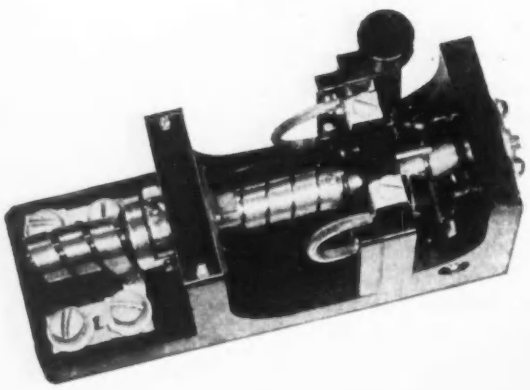
Experience has shown that Graphitar parts are not affected by hydrochloric acid, potassium dichromate, sodium hypochlorite, hydrogen peroxide, or other strong acids or chemicals. They render durable, reliable service in metal plating, cloth bleaching, metal pickling, and other industrial processes requiring the use of corrosive solutions.

The inherent ability to resist chemical action is only one of the reasons why Graphitar is practical for such a wide range of applications. Because it is self-lubricating and takes on a high polish, Graphitar is highly efficient for use as pistons and cylinder liners. It is extremely light in weight, yet mechanically strong. It will not warp or distort. Manufactured in several basic grades, Graphitar may be ground to tolerances as close as .0005" on small sizes.

If you manufacture a product requiring the characteristics of Graphitar, it will pay you to write for further information.

THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

PLASTICS IN VITAL MARINE CONTROL EQUIPMENT



• Watertown is producing these five essential parts for vital marine control equipment. They are transfer molded to provide maximum accuracy because alignment of the parts is all important.

Made from Resinox, Bakelite and Durez, each part embodies multiple inserts and is molded in multiple cavity molds. The sections are especially designed to withstand high impact and vibration. They are visible proof of what engineering skill combined with experienced molding techniques can produce in intricate sections held to exacting tolerances.

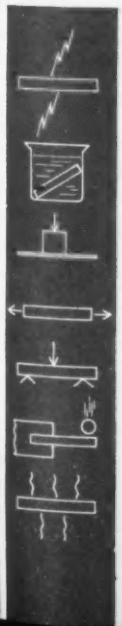
The Watertown Manufacturing Company, Watertown, Connecticut. Branch office — Cleveland. Sales offices — New York, Chicago, Detroit, Milwaukee and Hawaii.

Watertown

A NAME AS OLD AS THE PLASTICS INDUSTRY

A Scene From the Metro-Goldwyn-Mayer Picture—EDISON, THE MAN

The Birth of the "Little Sun" Every Home Welcomed



HIGH DIELECTRIC STRENGTH

LOW MOISTURE ABSORPTION
CORROSION RESISTANCE

COMPRESSIVE STRENGTH

TENSILE STRENGTH

FLEXURAL STRENGTH

IMPACT STRENGTH

STABLE OVER A
WIDE TEMPERATURE RANGE

Many More Properties—Combined

OF ALL man's inventions, one of the greatest, universally, was Edison's incandescent filament . . . a fine thread from which a new pattern of life was woven.

Edison simply experimented with known substances until he found one that met his singular requirements. You may have material problems, too. However, knowing your requirements, you may find your special answer in technical plastics.

If excellent electrical properties, resistance to corrosion, mechanical strength, easy machineability and many other combined characteristics are desirable, our type of technical plastics—Synthane—can be very helpful to you.

You are invited to send for the complete Synthane catalog and compare your needs with Synthane's advantages.

Synthane Corporation, Oaks, Pa.

SYNTHANE TECHNICAL PLASTICS

SHEETS • RODS • TUBES • FABRICATED PARTS **SYNTHANE** MOLDED-LAMINATED • MOLDED-MACERATED

Plan your present and future products with Synthane Technical Plastics

A comparison of SYNTHANE TECHNICAL PLASTICS with certain metals, debunking a popular notion that plastics being "magic" can be used indiscriminately

IT IS CHARACTERISTICALLY HUMAN to back a winner . . . to ascribe precipitately to vitamins or sulfa drugs or plastics more powers and claims than sober research can keep up with. Plastics have their possibilities . . . and their limitations. Good design is the reward of knowing both.

Plastics are doing many jobs that metals used to do, especially since certain critical metal shortages have cropped up. But, basically, plastics are *not* substitute materials. Correctly applied, they should and do stand solely on their own merits.

INTERESTING COMPARISONS TO PROVE the point can be made between our type of plastics—Synthane—and certain metals. Synthane is made by applying heat and pressure to paper or fabric impregnated with thermo-setting resins. It is non-metallic, a fact which should at once suggest uses fundamentally different from those of metals. Actually, Synthane is an excellent electrical insulator, and so you find it in hundreds of radio and electrical products and applications, not in place of metal, but to insulate metal. That does not imply Synthane cannot replace metal. As a matter of fact, Synthane has taken over for metals in pulleys, bearings, panels, structural members, scales, dials. The reasons can usually be traced to one or a combination of the many properties of Synthane technical plastics.

ONE OF THE PRINCIPAL REASONS at present is light weight. Synthane has a specific gravity ranging from 1.20 to 1.70, about half that of aluminum, less than magnesium. So in many unstressed parts for aircraft Synthane is a logical consideration.

SYNTHANE LAMINATED PLASTICS GENERALLY have lower mechanical strength than metals for a given cross section. For example, an approximate comparison might read like this:

	Tensile Strength (p.s.i.) ultimate	Compressive Strength (p.s.i.)
Alloyed Aluminum	16,000–60,000	9,000– 47,000 (y)
Brass	40,000–80,000	28,000–126,000 (u)
Cast Iron	16,000–45,000	80,000–200,000 (u)
Synthane	8,000–12,000	30,000– 50,000 (u)

(y—yield strength
u—ultimate strength)

IT IS IMPORTANT, HOWEVER, TO REMEMBER that on a *weight* basis, Synthane may be stronger though redesign of a part for plastics may be necessary.

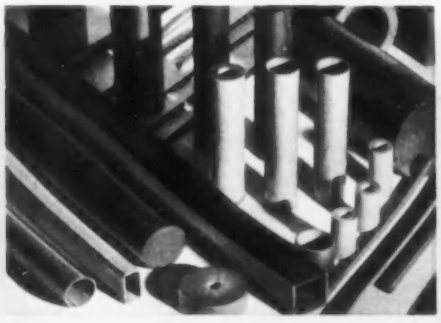
HARDNESS IS A PROPERTY in which another interesting comparison of Synthane with metals can be made. Brinell hardness, tested with 500 Kg. load, 10 mm ball, shows approximately these values: Alloyed aluminum 45–110, Brass 95–150, magnesium (drawn annealed) 29, annealed cast iron 77, Synthane 24–40.

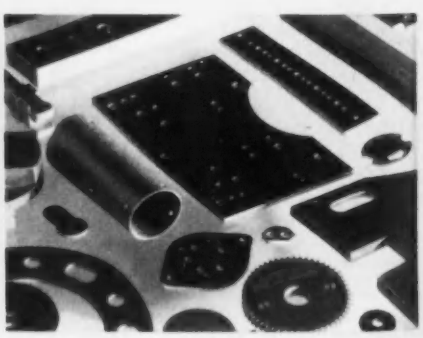
BEHAVIOR UNDER TEMPERATURE CONDITIONS is characteristic of Synthane's non-metallic composition. For instance, whereas the thermal conductivity of aluminum alloys may range from .20 to .54 calories per second per square centimeter per centimeter of thickness per degree C., Synthane's thermal conductivity is about .0005 to .0008. The coefficient of thermal expansion of Synthane is about .0000140 inches per inch per degree F., approximately the same as alloyed aluminum, slightly more than pure aluminum, copper, brass.

CORROSION RESISTANCE IS A SUBJECT of such complications as to temperature, degree of concentration, and type of agent that any comparison with metals would necessarily be lengthy. Synthane does resist corrosion from water, many acids, oils, and salts, and to a greater or lesser extent than metals depending on the metal with which it is compared and the corrosion conditions. Synthane is extensively used as a corrosion resistant material.

APART FROM ITS PHYSICAL, CHEMICAL, electrical and chemical properties, Synthane may be easily and quickly machined by ordinary shop methods, a point which may occasionally influence selection when other factors are the same. And, just as metals are cast for economy in large quantities, so Synthane is available in two molded forms, molded-laminated and molded-macerated, for economy of duplication.

OBVIOUSLY, IN CERTAIN CASES there can be no question of whether to use Synthane plastics or a metal such as when the material must be an electrical conductor or an electrical insulator. In other cases, weight or strength may decide, or corrosion resistance, resilience, hardness, machinability. Or as often happens, the decision may rest upon the extent to which the material required meets many combined specifications. Synthane technical plastics are usually more desired for their combination of properties than for any one specific property for which another specific material or metal may be the only logical answer.



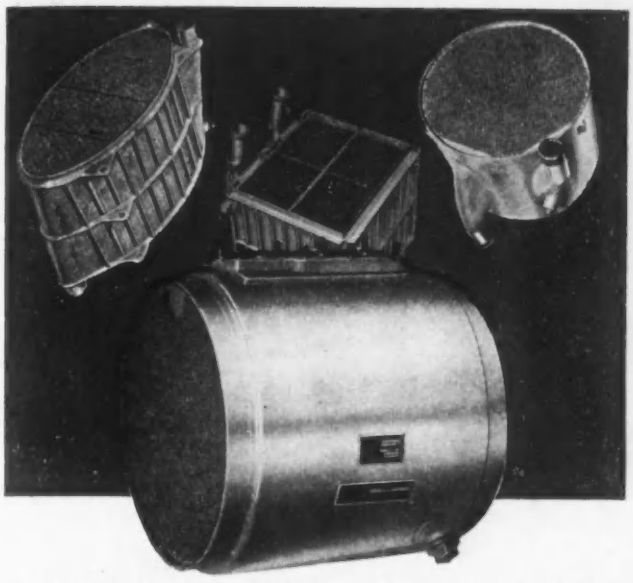


SYNTHANE

PLAN YOUR PRESENT AND FUTURE PRODUCTS WITH SYNTHANE TECHNICAL PLASTICS · SHEETS · RODS · TUBES · FABRICATED PARTS · MOLDED-LAMINATED · MOLDED-MACERATED

SYNTHANE CORPORATION, OAKS, PENNA.

REPRESENTATIVES IN ALL PRINCIPAL CITIES



ALUMINUM BRAZING VS. SOFT SOLDER

A heat transfer unit is only as strong as the bond that fastens its tubes to header plates or shell. The soft solder used for sweating copper units is low in resistance to temperature, pressure, vibration and shear. Silver solder or other high-melting-point solders can't be used because they anneal and weaken the copper at the soldering point.

ADVANTAGES OF ALUMINUM BRAZING

Clifford's discovery of the long-sought method of brazing thin-walled aluminum tubes brought four recognized advantages to heat-transfer engineers of the USAAF.

1. A saving of ⅔ the weight of copper in the same size and shape.
2. Heat-treatable aluminum tubes that don't break down under working temperatures as high as 275°F. instead of copper tubes that gradually anneal and weaken.
3. Heat-treatable aluminum alloy header plates, shells and other parts that stand up under much higher temperatures and pressures than other metals commonly used in heat transfer units.
4. An aluminum alloy bonding material capable of withstanding temperatures, pressures and strains several times higher than soft solder's limits.

Performance records of Clifford Feather-Weight Oil Coolers and Coolant Radiators in several types of USAAF fighters verify these advantages.

POSTWAR APPLICATIONS

Although Clifford's production is now 100% in war work, inquiries and suggestions about postwar applications of all-aluminum heat-transfer units to automotive, heating, cooling and ventilating fields will be given full consideration. *Save ⅔ the weight . . . same size and shape.* Clifford Manufacturing Co., 562 E. First St., Boston 27, Massachusetts.

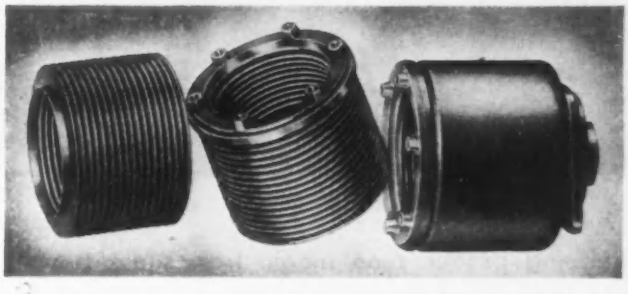
IN HYDRAULICALLY-FORMED BELLOWS

only the fittest survive

Of all the tests Hydron Bellows must pass before they go to work for you, the first is the most severe. That's the test of the manufacturing process that gives them shape . . . hydraulic forming.

Figure it out for yourself. Take a paper-thin metal tube. Force the walls transversely between the plates of a collapsible die *under internal hydraulic pressure amounting to several hundred pounds per square inch.* Tubes with imperfections or flaws can't take it. They are automatically rejected by the process.

That's why every Hydron Bellows is a sound metallurgical specimen . . . with no seams, tool marks or hidden flaws. And, further, that's why each Hydron Bellows has plenty of flexes left in its system when less severely tested bellows have quit on the job.



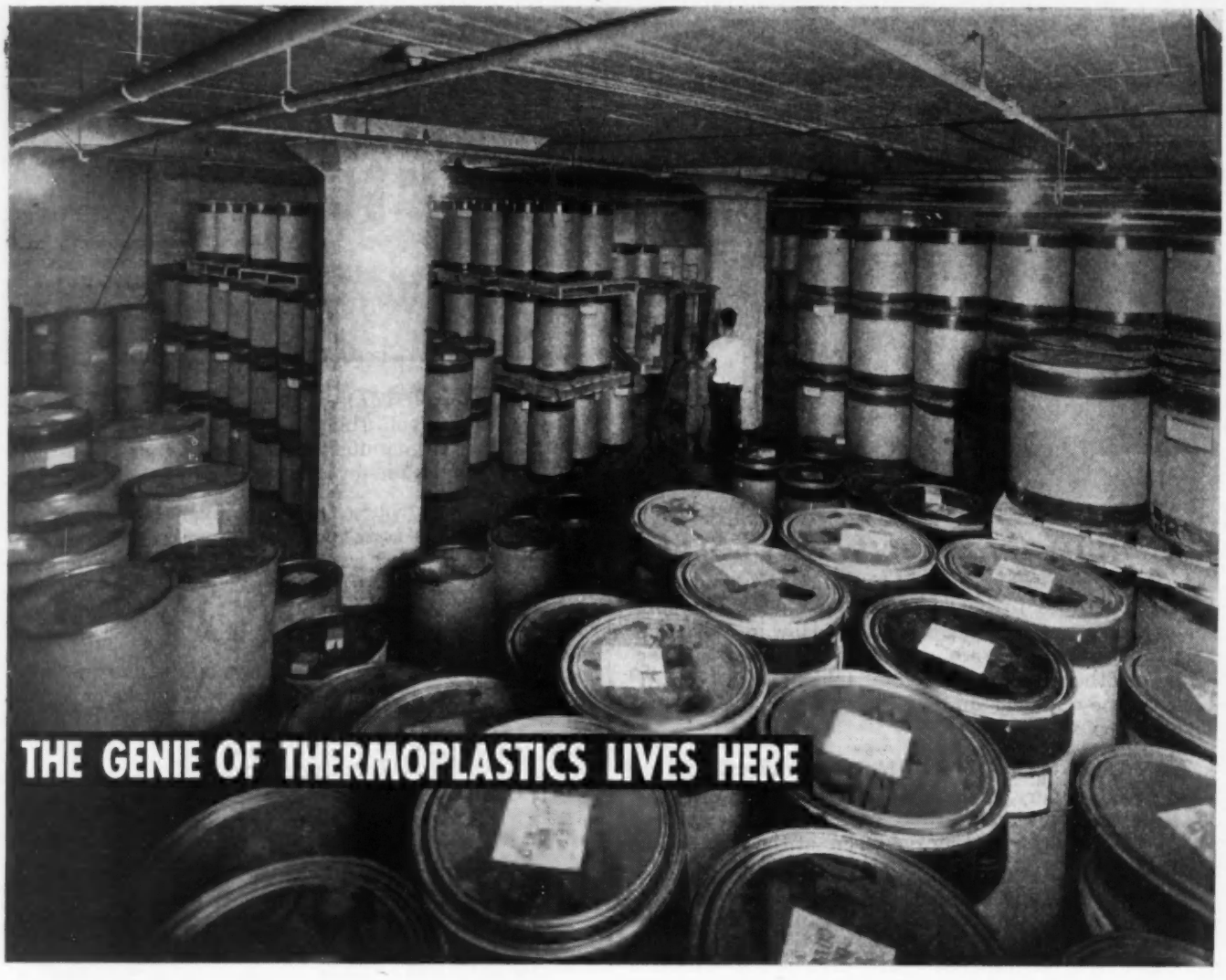
Naturally, when Clifford builds these perfect Hydron Bellows into assemblies for temperature and pressure control or for shaft seals and other exacting uses, every precaution is taken to preserve that inborn perfection.

Because the same men who produced industry's first hydraulically-formed bellows — Hydron — are still on the job, Clifford is equipped, perhaps better than anyone else, to supply you with these uniform, pretested hydraulically-formed bellows either as such or in highly-engineered bellows assemblies. *First with the Facts on Hydraulically-Formed Bellows.* Clifford Manufacturing Co., 562 E. First St., Boston 27, Massachusetts.

CLIFFORD *Feather Weight* OIL COOLERS AND COOLANT RADIATORS

HYDRAULICALLY-FORMED BELLOWS

HYDRON Metal Bellows



Rubbing produces no magic from these barrels, but from under their covers, with our wide moulding experience, have come the answers to scores of plastic problems. Some have been giants to solve, but tiny as products. Others are just the other way around.

As you know, the amount of powder allowed on inventory is strictly limited today. Yet by the time you read this message, a good share of the powder you see will be gone — only to be replaced again. Many more answers are there, answers you want to know and which we can supply. Whether you have thought in terms of thermoplastics or not, the Trio can help you from your first question about any type of plastic moulding.

For Custom Injection Moulding . . . try the Trio

Custom Injection Moulders

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BONDERIZED

ZINC COATED

SHEET STEEL

A NEW TYPE OF MILL TREATED SHEET

Bonderized, zinc coated sheet steel provides the ideal material for furnace housing and air ducts. It has the rust resistance and paint holding qualities necessary for this type of construction. It resists the humidity of air conditioning, assures continued fine appearance of the enamel finish—and appearance is an important sales factor.

The Bonderized, zinc coated sheet as supplied by steel mills is an interesting new product for users of sheet or strip steel. The coating aids drawing qualities, as well as adding rust resistance and an excellent base for paint. This is a thoroughly workable sheet for practically all forms of fabrication that adds acceptance, color and sales appeal to your product.

PARKER RUST PROOF COMPANY

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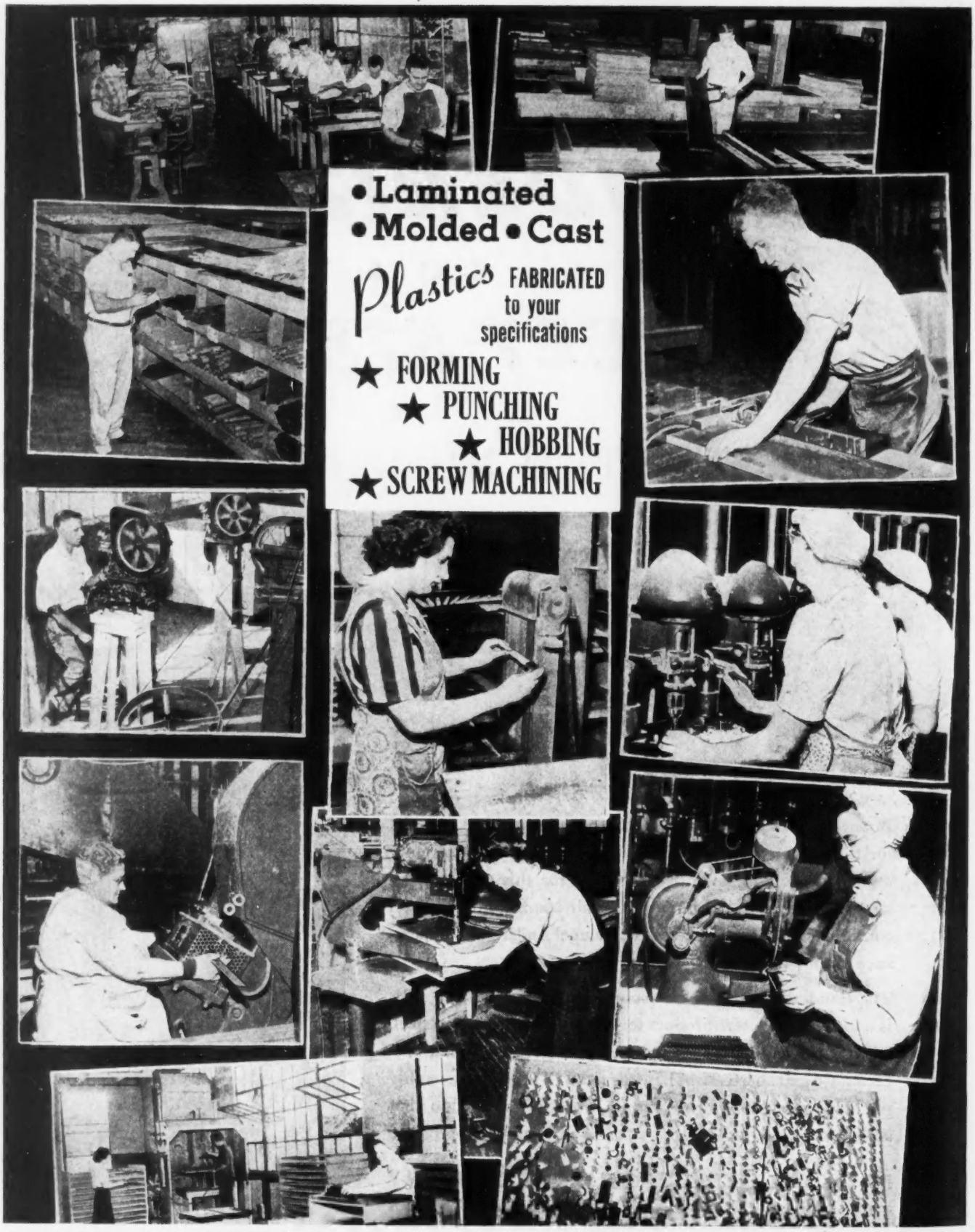
BONDERIZING • **PARKERIZING** • **PARCO LUBRIZING**

HOLDS PAINT TO STEEL — INHIBITS RUST — RETARDS WEAR

PARKER PRODUCTS CONQUER RUST



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Improve SIZING OPERATIONS with KENNAMETAL Balls

Kennametal's modulus of elasticity, 2 to 3 times that of steel, enables it to effectively resist deformation. This property, in combination with amazing wear-resistance due to exceptional hardness, ideally suits Kennametal balls for economical, accurate burnishing operations. For example—Kennametal balls, used to burnish holes to size in hardened steel bushings 3/4" long, held tolerance and concentricity for 60,000 operations. Steel balls, on the same operation, produced only 600 sizings. On this job, the use of Kennametal balls practically eliminated defective work, and saved approximately 90% of the time previously required to check gage of holes sized with steel balls.

Kennametal balls can be supplied from stock in ten standard sizes, ranging from 1/8" to 1" diameter. Special sizes can be provided. Catalog 44 contains particulars and prices. A copy is yours for the asking.

Advantages of KENNAMETAL Balls

- Hold size within tolerance for thousands of operations.
- Improve concentricity, and maintain gage of hole.
- Produce work-hardened, mirror-smooth finish.
- Reduce rejects to a minimum.

KENNAMETAL
SUPERIOR CEMENTED CARBIDES
KENNAMETAL Inc., LATROBE, PA.

modern steels win wars . . . build for peace!

EQUIPMENT and experience accumulated by the steel industry in peacetime proved to be tremendous assets for a nation at war. They gave us a running start.

Approximately $1,063,000,000 in Government funds were invested during wartime expansion. The industry itself spent $1,151,000,000 in expanding and modernizing—matched the Government dollar for dollar.

The iron-ore industry achieved a miracle of wartime production.

Lake ore fleets set records.

Pig iron production was pushed to the utmost.

A shortage of scrap was averted.

The industry had a brilliant corps of metallurgists who were able to solve seemingly insoluble problems. One by one each of the important alloy materials—chromium, cobalt, manganese, molybdenum, nickel, tungsten, vanadium—became hard to get in adequate quantities. Whole new families of steels were conceived around conference tables in the offices of American Iron and Steel Institute.

The new steels, known as NE (National Emergency) steels, while economical in their use of alloys, are in no sense an "ersatz" product. The first two series of such steels, announced early in 1942, were as strong as standard alloy steels having four times as large an alloy content.

Conservation was accelerated when technical committees reported on certain hardening agents which contain such elements as boron, titanium, or zirconium. These cut down the amount of alloys required.

Practically all important parts of military equipment are made of alloy steels. Modern guns, small arms, armor, projectiles, airplane engines, aircraft fuselage tubing, and even helmets are almost entirely alloy steel.

Military applications required combinations of strength, hardness, ductility, and fatigue resistance not duplicated by any of the standard peacetime steels.

Not once has any war plant had to shut down for want of steel.

The steel industry of the United States is proud of its contribution to victory; and some of the alloy steels thus produced for the first time, some of the new methods of treating and fabricating steels, to make submarine skins, airplane wing coverings, or armor-piercing shot, are likely to be useful long after the war is over.

* * * * *

The foregoing paragraphs are condensed from an admirable recent pamphlet, "Steel's War Record," issued by the American Iron and Steel Institute, to which acknowledgement and compliments are offered by the Molybdenum Corporation.

AMERICAN Production, American Distribution, American Control—Completely Integrated.
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GRANT BUILDING PITTSBURGH, PA.

MCA

P & N DIRECT LINE
Swaged Hooks
OFFER NEW SAFETY FEATURES!
Sizes for 3/16" to 1" cable
Tightly swaged—Give foul-free surface
Straight shank
Load is carried on direct line from cable, prevents slipping
Precision forged of alloy steel
Ample radius
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Now for the first time Poulsen & Nardon offer a complete line of hooks that can be swaged to cables from 3/16" to 1" in diameter. This permits faster, safer fastening. No more costly splicing with jagged, dangerous ends. P & N Direct Line Swaged Hooks are smooth, streamlined and foul-free!
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"How about economical TOOLING for those STREAMLINED designs?"

Often, when designing a product for greater eye-appeal or improved utility, a coordination with efficient tooling is not given sufficient consideration. Result . . . slow production, high cost, competitive disadvantage.

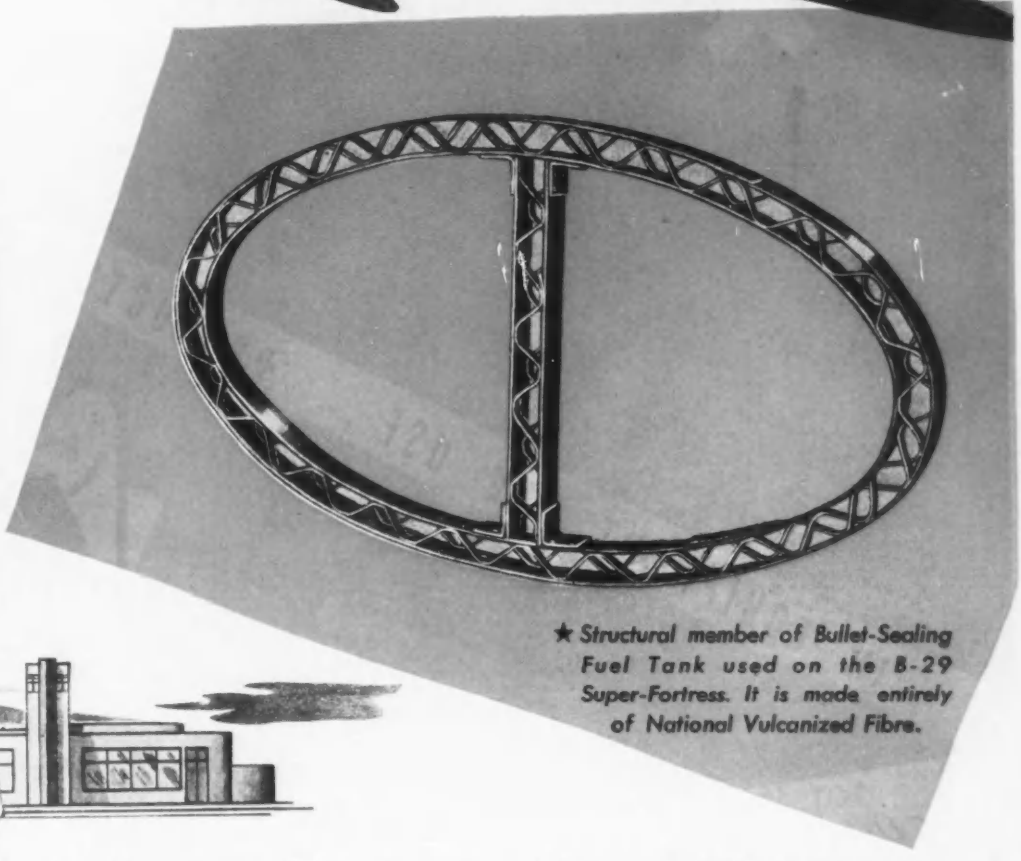
One remedy for such a situation will be found in employing Atlas . . . an organization of 300 skilled Engineers, Designers and Toolmakers, with one of the best equipped plants in the East. Atlas product designers work in close association with their engineers and toolmakers . . . as well as your key men . . . to design product, tools, dies, jigs, assembly and testing equipment, if required, and in many instances, special automatic machinery for economic manufacture.

Atlas technicians have served scores of America's leading industrial concerns before and during the war in such fields as transportation, textiles, machine tools, printing machinery, motors, radios, cameras, electronics, aviation, stoves, air conditioning and refrigeration . . . and of late, designing and tooling for tank parts and guns, anti-aircraft, electrical weapons, shells, engine starters, superchargers, including complete production lines for the precise manufacture of vital war material.

On request we will gladly send you an Atlas Brochure which gives a clear picture of Atlas operations, machine shop sections, together with their modern equipment, and a partial list of Atlas clients, a veritable "Who's Who" in industry. Send for your copy . . . then "call Atlas".

A load off your shoulders onto ours

ATLAS TOOL & DESIGNING COMPANY
ATLAS METAL STAMPING COMPANY
Castor & Kensington Avenues, Philadelphia 24, Pa



★ *Structural member of Bullet-Sealing Fuel Tank used on the B-29 Super-Fortress. It is made entirely of National Vulcanized Fibre.*

Is there an Idea for your New Products in this War-time Use of National Vulcanized Fibre?

National Vulcanized Fibre, because of its remarkable combination of properties—resilience, formability, lightness in weight and exceptional strength—was found to be exactly the right material for this structural member of the bullet-sealing fuel tank of the B-29 Super-Fortress. Its superior resiliency and shock-absorbing qualities protect the tanks from the sudden and great impacts of landing. The same properties that make National Vulcanized Fibre the best material for this and thousands of other war-time applications make it equally practical for countless peace-time uses. National Vulcanized Fibre may be the means of developing new, profitable products for you—of enabling you to get the lead on your post-war competition.

• • •

National engineers are available today to assist you in your current design and research work. Write, phone or wire us.

Electrical Applications—National Vulcanized Fibre, in combination with its exceptional physical and mechanical properties, has high dielectric strength which makes it the one best material for numberless electrical and electronic uses.

NATIONAL VULCANIZED FIBRE CO.

Wilmington, Delaware *Offices in Principal Cities*

Rx FOR PARTS THAT WEAR EXCESSIVELY

IN EQUIPMENT YOU USE . . . PRODUCTS YOU SELL

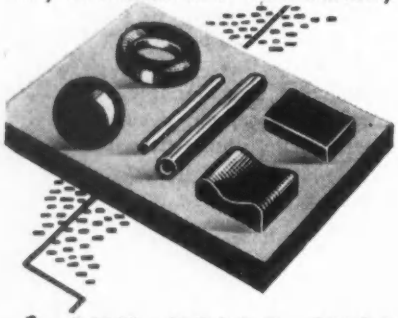
UP TO 100 TIMES LONGER LIFE

☆ *Simply insert Carboloy Blanks at Vital Wear-Spots*

Here's a fast, inexpensive way to step up the life of your product parts often as much as 100 times . . .

Simply "wear-proof" with Carboloy Cemented Carbide. Carboloy blanks—made to shape and size desired—may be brazed-in or mechanically fastened at the point of wear, or the entire part may be made of Carboloy metal.

Now widely used throughout industry as the simple, economical answer to many annoying problems of excessive wear. Write for free booklet WR-101.



☆ ANY SHAPE AVAILABLE

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TRADE MARK

FOR WEAR-RESISTANT USES

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Chicago • Cleveland • Houston • Los Angeles • Milwaukee • Newark
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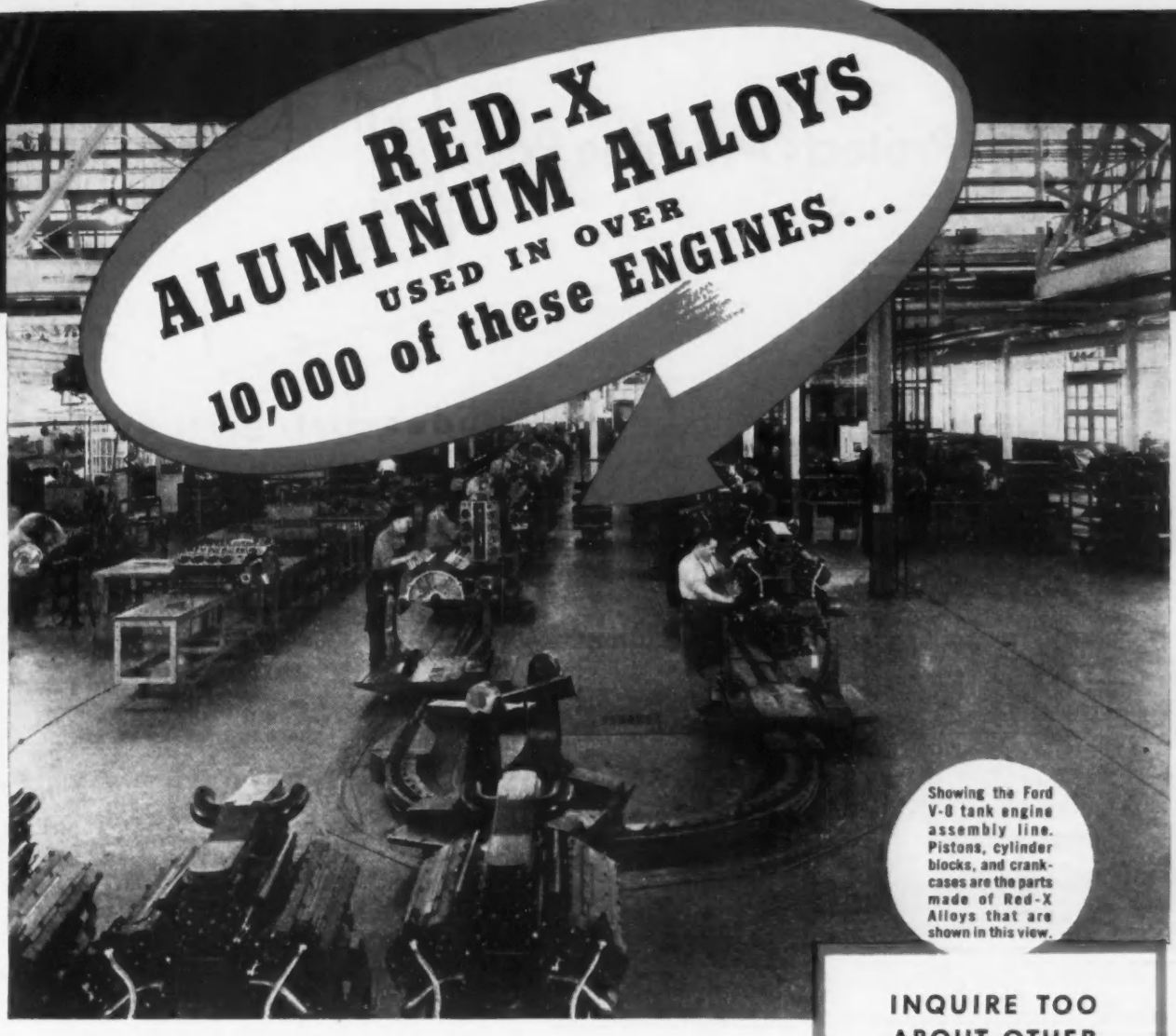
RED-X ALUMINUM ALLOYS

USED IN OVER 10,000 of these ENGINES...



Showing the Ford V-8 tank engine assembly line. Pistons, cylinder blocks, and crankcases are the parts made of Red-X Alloys that are shown in this view.

Wide use of Red-X Aluminum Alloys in the automotive, marine and railroad fields, as well as in armament for all branches of the Services, is proof of their uniformly satisfactory performance in critical castings.

This ability of Red-X Alloys to meet the exacting requirements of many critical castings comes from the fact that they are "custom made" to fit the job.

In addition to high quality and good production and use performance, Red-X Alloys offer the further advantage of *economy*.

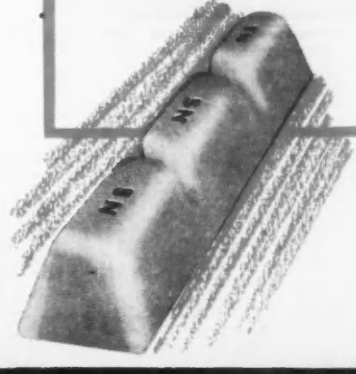
Write for additional information and copy of 16-page illustrated booklet.

The NATIONAL SMELTING Co.
6712 Grant Avenue • • • Cleveland 5, Ohio

INQUIRE TOO ABOUT OTHER

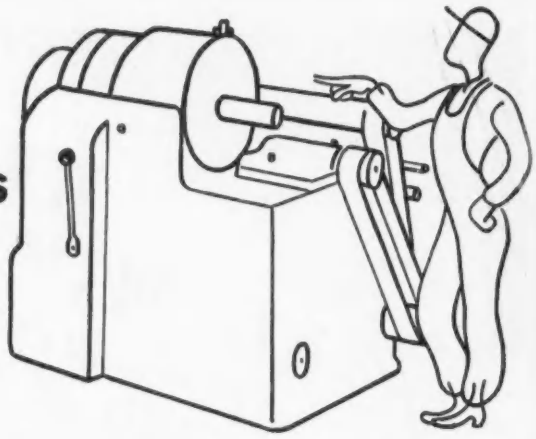
National BRAND

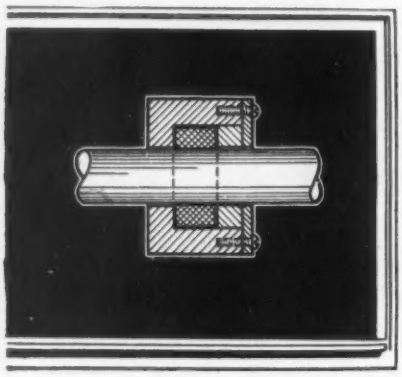
ALUMINUM ALLOYS



NATIONAL SMELTING

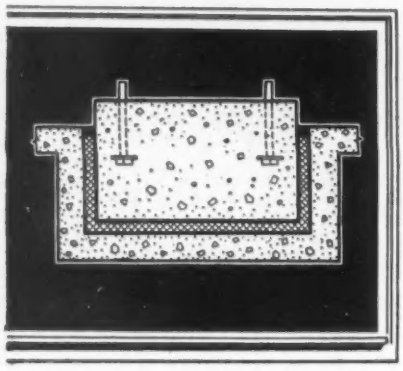
Felters Felt Protects Machine Parts





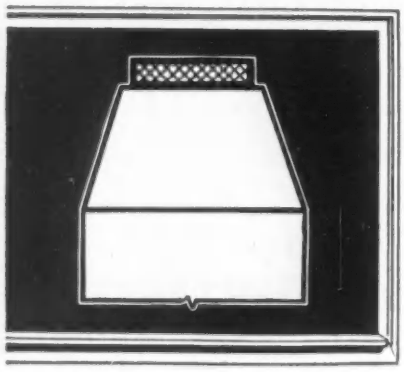
it excludes dirt, grit, dust

Felters Felt keeps bearings running true, with a consequent gain in accuracy; guards against loss of lubricants resulting from bearing wear. Low maintenance cost.



it absorbs vibration

Because it is highly resilient, with a predictable permanent set; will not deteriorate with age or exposure to water, oil, gasoline or acid in normal concentrations, Felters Felt is ideal as the medium for increasing the accuracy of machine settings, reducing maintenance and fatigue problems arising from transmitted vibration.



it is a lubricant feeder

Because of its wicking action, Felters Felt may be used to conduct lubricants from reservoirs to points of application. Highly resilient, it maintains close contact with an extreme minimum of friction. Many other uses for the felt that cuts without fraying are described in "Felt as a Design Material", a copy of which may be obtained by writing to The Felters Company, 210 D South Street, Boston, Massachusetts.

_____ put in your post-war picture

"Sighted Jap Force . . . moving in to attack!"

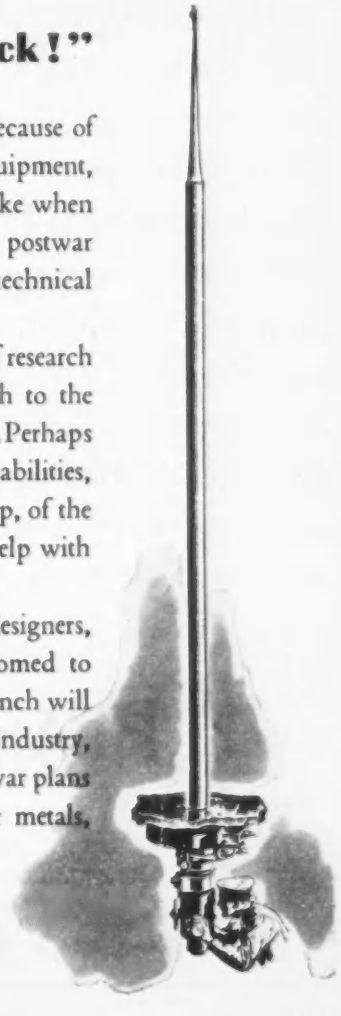
West of the Philippine archipelago, two U.S. submarines patrolling before dawn saw the strong Japanese task force which had advanced from the South China Sea . . . flashed a warning, and added characteristically . . . "We are moving in to attack!"

THE bold sortie was successful. The two scouts hit three heavy cruisers, with four torpedoes for each, sank two big Atago class cruisers, severely damaged a third, scattered the enemy's force. Confusion allowed ample time for our own task forces to arrive, and meet the Japs in one of the most decisive engagements of the war, the Second Battle of the Philippines. The surviving Japanese ships fled, leaving a sea dotted with Imperial Navy caps, assorted wreckage, and oil slick for hundreds of miles.

A submarine attack succeeds because of the planning, initiative, sound equipment, trained men, and the ability to strike when opportunity arises—and meeting postwar competition will likewise require technical competence, skills, experience.

Kollmorgen's quarter century of research and development has added much to the effectiveness of submarine periscopes. Perhaps the engineering and manufacturing abilities, and the fine precision craftsmanship, of the largest makers of periscopes can help with your peacetime products.

When war ends, lens makers, designers, machinists, and engineers, accustomed to tolerances of five millionths of an inch will welcome new assignments from industry, science, and medicine. If your postwar plans embrace high accuracy in glass or metals, consult with Kollmorgen—now!



KOLLMORGEN OPTICAL CORPORATION

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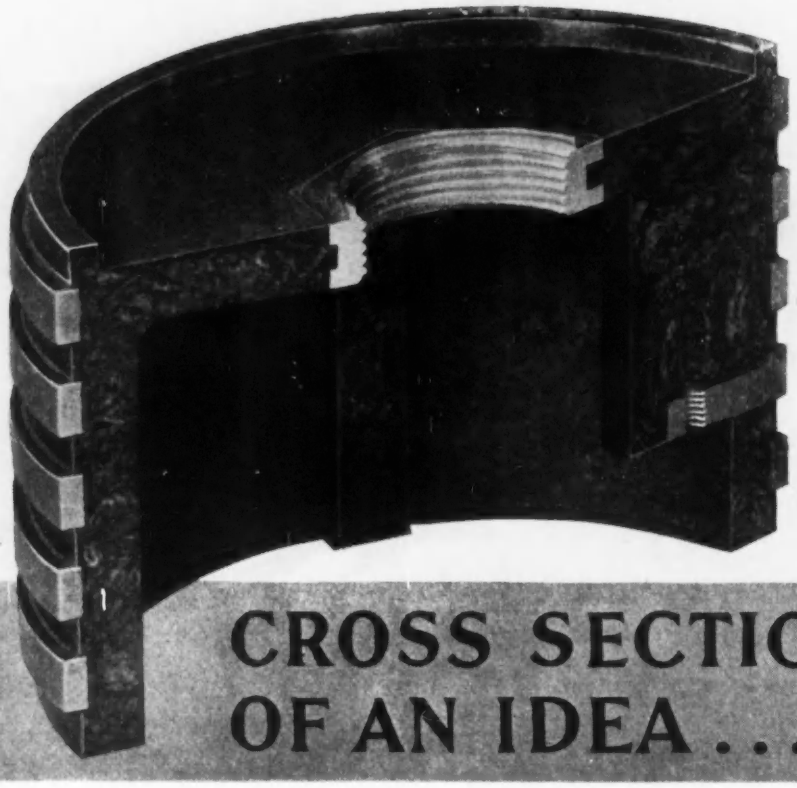

MEMBER SOCIETY OF THE PLASTICS INDUSTRY · SPI

CROSS SECTION OF AN IDEA . . . . .

THE CROSS-SECTION above is part of a molded commutator. Before it was brought to us for improvement, this item was made in numerous parts and assembled. Now it is transfer-molded in one piece, complete with metal rings and inserts—all in permanent alignment. The ease and precision with which metal inserts can be molded by us greatly extends the use of phenolic plastics. Working with combinations of plastics and metals our design engineers have developed some original techniques that have solved a number of product problems • Consider the picture as a cross-section of an IDEA. It represents the type of ideas that might be developed now for the improvement of your postwar products through engineered applications of molded plastics. Ideas to cut costs. Ideas to improve performance. Ideas to save time in manufacture. Our ideas are available to help with your current wartime production and to assist in your postwar planning. Consult with us now.

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For handy and helpful facts on our plastics services, write for free Folder File PE2

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Precision is our goal . . . precision beyond the usual . . . such as the extremely fine tolerance of two-ten thousandths delivered to Uncle Sam. Because we have repeatedly convinced a multitude of doubters through our ever more exact control of gauges and physicals in cold-rolled strip steel, we are encouraged to go on striving for the unattainable, the impossible.

CMP CONTINUES to PIONEER in PRECISION COLD ROLLING of STRIP STEEL

Profit by CMP's huge store of light gauge metal production knowledge. Let a CMP specialist recommend or develop the exact metal for your needs. Test it in your own manufacturing processes. You'll find that CMP's uncanny accuracy in gauge and the skilled control of a wide choice of physicals makes THINSTEEL THE STEEL for protection of dies and machinery . . . elimination of waste . . . increased production of parts per ton . . . consumer satisfaction. Yes, it's worth your investigation.

THINSTEEL FACTS: Gauges thin as .001" Widths up to 24". Coils up to 300 lbs. per inch of width. Extremely close tolerances. Standard finishes. Carbon grades. Wide range of physicals.

CMP — PRECISION COLD ROLLED STRIP STEEL

GIVES MAXIMUM PRODUCTION PER TON

THE COLD METAL PRODUCTS CO.

SUBSIDIARY OF THE
COLD METAL PROCESS CO.
YOUNGSTOWN, OHIO

Glass gives you more than transparency . . . *far more!*

It is the *combination* of favorable characteristics that makes glass the ideal material for many of its common uses!

Take windows, for example. Glass is used for its transparency, to be sure. But also because it stands up under the most difficult weather—year after year—without any harm to the smoothness and hardness of its surface. Because it keeps its original luster and beauty without any refinishing. Because it *stays* easy to clean.

When you think of the materials to use for your postwar products, or for the improvement of your plant equipment or processes, bear in mind the combination of characteristics that gives glass the stamina—the durability—to do jobs that no other material can do so well.

And remember that glass is versatile—available in many finishes, colors, shapes and weights. We'd welcome the opportunity to discuss how the performance characteristics of glass can help you. Libbey·Owens·Ford Glass Company, 6025 Nicholas Building, Toledo 3, Ohio.

Here's the combination that makes GLASS one of the world's most versatile materials:

CHEMICALLY, the most stable of all materials, except the noble metals. Won't rot, oxidize or disintegrate, plus—

DIMENSIONALLY STABLE. Coefficient of expansion extremely low. Keeps its shape, plus—

SURFACE, among the world's hardest and smoothest. Non-porous, won't absorb odors or moisture. More acid-resisting than any structural material. Unusual resistance to abrasion. Weathering qualities unequaled, plus—

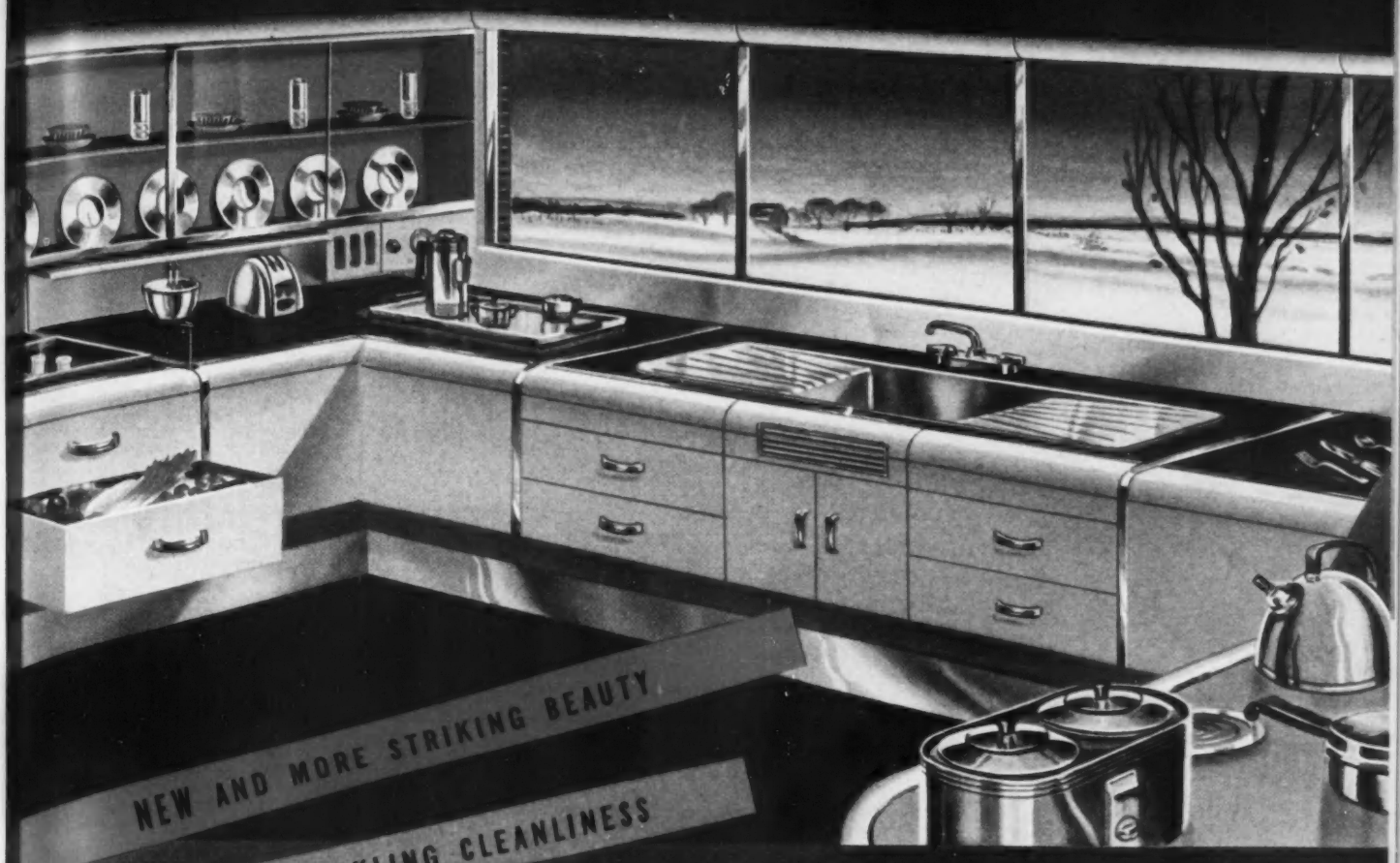
STRONG, tempered glass is stronger than some metals. A square foot, ¼″ thick withstands pressure of 60 lbs. per sq. in. and thermal shock of 400° F. Will not burn, plus—

ELECTRICAL INSULATOR of outstanding strength.

LIBBEY·OWENS·FORD
a Great Name in **GLASS**

Destructible? **Wood — Metal — Plastics — Glass. No material is indestructible. However, barring unforeseen conditions, no material will fail on a job in which it has been properly specified and engineered. When our application engineers say "Yes", you can be sure about glass.**

IN NEW-DAY KITCHENS



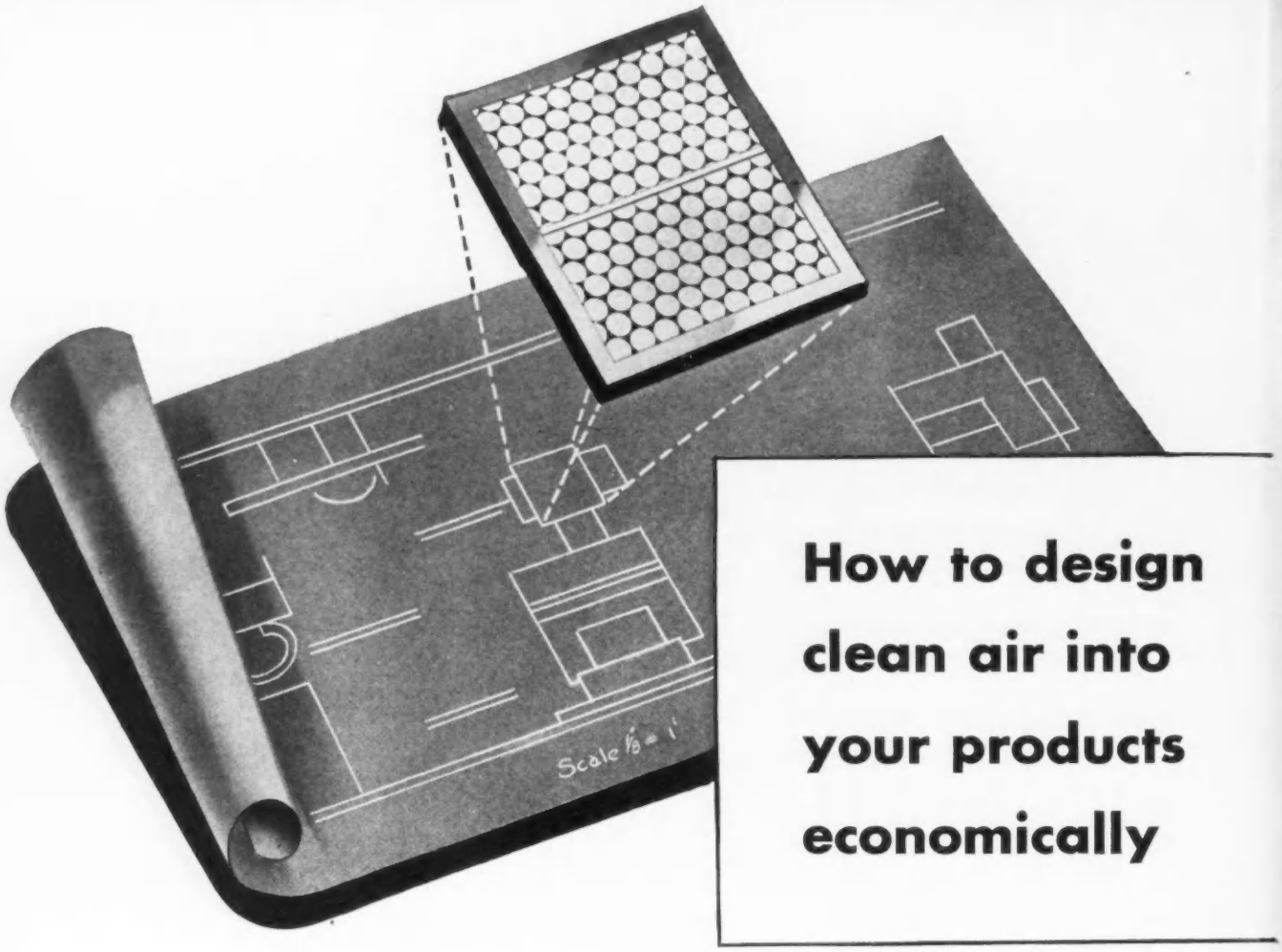
WITH

SUPERIOR STAINLESS STRIP STEEL

Stainless steel, employed by the designer for its exceptional utility, durability and appearance, expresses completely the functions of the modern kitchen. Impervious to corrosion, high in strength to resist dents and scratches, bringing peerless luster to moldings and trim, fittings, utensils, flat ware, kitchen electrical appliances and decorative ware, stainless "cleans like a dish" to the joy of every user. These paramount qualities are inherent in SUPERIOR Stainless Strip Steel, plus the great fabricating advantages of long continuous coils in specified widths and thickness . . . uniform compositions and tempers in the various grades . . . precision rolled by *strip steel specialists.* Consult with us on your coming requirements!

Superior Steel

CORPORATION CARNEGIE, PENNSYLVANIA



How to design clean air into your products economically

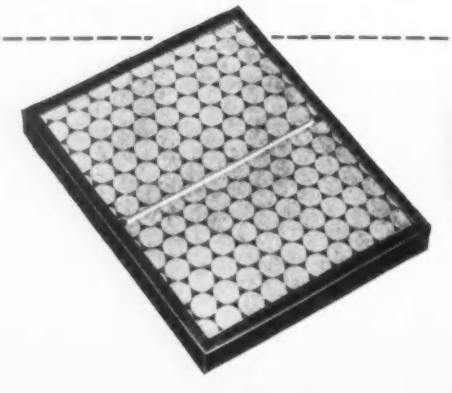
The experience of many designers has proved that the economical way to provide the advantages of clean air, economically, is to specify Dust-Stops* as a component part of the product. These low-cost, replaceable air filters are now used on many types of machinery and equipment to protect precision parts against abrasive dust, to increase efficiency and to facilitate operation under adverse conditions.

Dust-Stops are constructed of packs of glass fibers coated with an adhesive, faced with punched metal grilles and bound on the edges with a fiberboard frame.

The Fiberglas filter medium is coated with a nonodorous, nonevaporating adhesive having extraordinary wetting power. Each impinged particle of dust is quickly soaked, acting as a wick to carry adhesive to other particles. Thus the adhesive remains effective until the filter is so heavily coated with dust that resistance to air flow calls for replacement.

Because of their low cost and ready availability from suppliers in nearly every community, Dust-Stops that have done their job can be easily and economically replaced.

If you are concerned with either stationary or mobile equipment which could attain competitive or operating advantages by use of Dust-Stop Air Filters, write for complete information today: *Owens-Corning Fiberglas Corporation, 1913 Nicholas Building, Toledo 1, Ohio. In Canada, Fiberglas Canada Ltd., Oshawa, Ontario.*

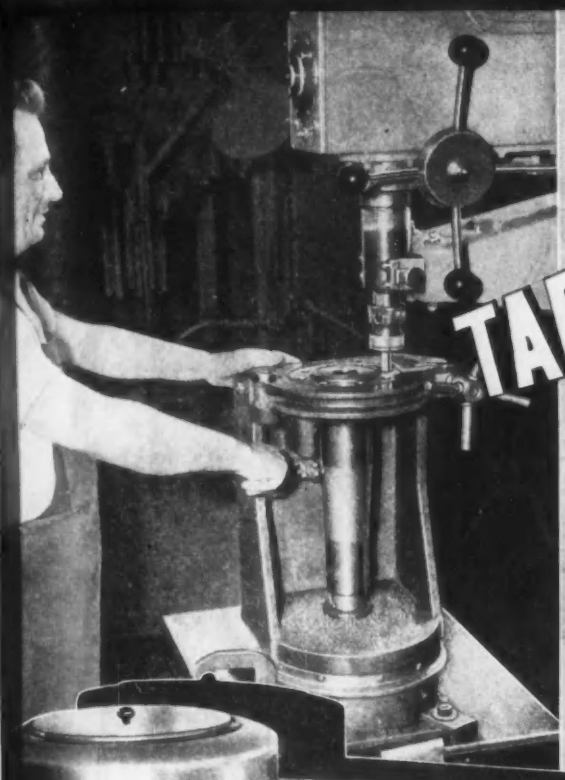


DUSTOP AIR FILTERS

*T. M. Reg. U. S. Pat. Off.

ARMY E NAVY

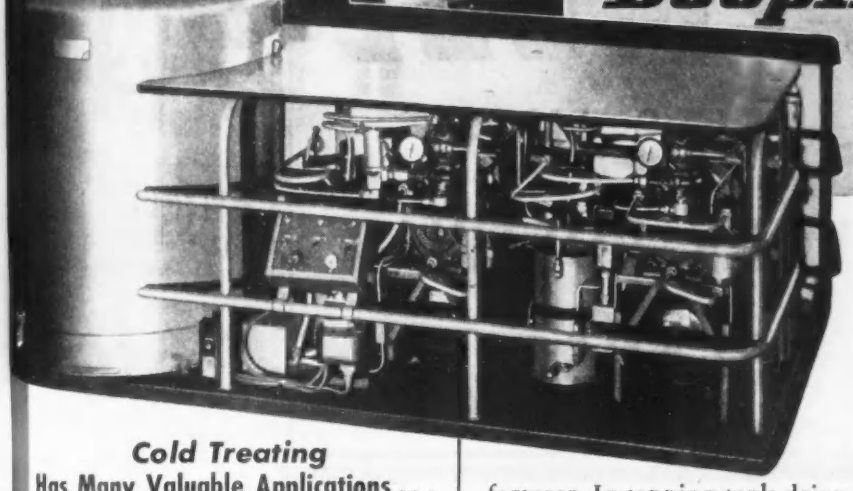
—a FIBERGLAS product



The tap on this vital operation produced 84 pieces after cold treating. It was still sharp and true.

TAP LIFE INCREASED

From 7 to 84 Pieces per Sharpening . . . by *Cold Treating* in a *Deepfreeze* Industrial Chilling Machine!



Deepfreeze Cold Treatment Cuts Costs by Increasing Tool Life . . . Increases Production by Cutting "Down Time" of Machines on Vital Operations

The value of applying Deepfreeze cold treating to increase cutting life of small tools is exemplified by the experience of this manufacturer. In tapping tank drive gear parts it was found that after machining a relatively few pieces, the crest of the 1/2" pipe tap burnished or the tap chipped on face of thread. This made frequent sharpening necessary, proved extremely costly and slowed production considerably.

To remedy this and to reduce interruptions in the production of this operation for frequent tool changes, taps were subjected to the sub-zero treatment in a Deepfreeze −120° F. Industrial Chilling Machine.

Photomicrographs taken both before and after treatment showed that the cold-treated tap had a much finer Martensitic structure with little Austenite. Rockwell "C" Scale hardness of the metal was increased from 64 to 65 1/2. Actual tests revealed that over 84 pieces could be tapped per sharpening with the cold-treated taps against 7 pieces average for untreated taps . . . for an *increase in tool life of 1200%*.

In addition, the quality of the work with the cold-treated taps more closely adhered to air corps specifications for thread-smoothness and accuracy. Machine "down time" was also perceptibly decreased.

Cold Treating Has Many Valuable Applications . . .

Deepfreeze Cold Treating has proven profitable in many industrial applications. New uses are reported every day. Here are just a few:

1—Treating high-speed steel cutting tools.
2—New shrink-fit assembly applications.
3—Stabilizing gauges and other precision instruments.
4—Dimensional stability obtained in parts requiring close tolerances.
5—Elimination of distortion after machining.
6—Salvaging of parts and tools.
7—Testing of instruments and materials.

FREE BOOKLET . . . Cold Treating Practice with a Deepfreeze

Up-to-the-minute facts that will show how you can profitably apply it to your own production. It also lists numerous cold treating procedures successfully employed by such manufacturers as Ford Motor Company, Kearney & Trecker Corporation, Savage Tool Company, etc.—procedures which, possibly, you can use. Write for your copy today. Ask for Bulletin I-4.

Only Motor Products can make a "DEEPFREEZE"

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TRADE MARK DEEPFREEZE REGISTERED UNITED STATES PATENT OFFICE

Industrial Chilling Equipment for Shrinking, Testing, Hardening and Stabilizing Metals

DIVISION OF
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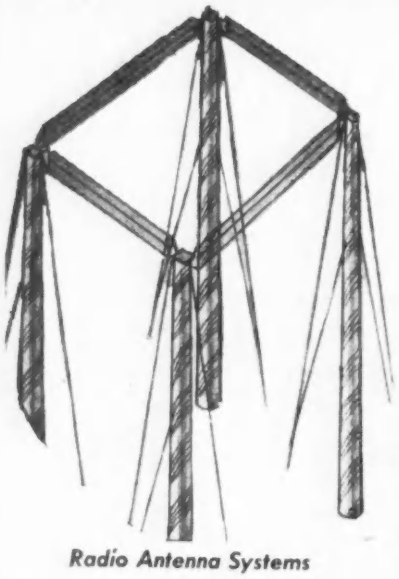
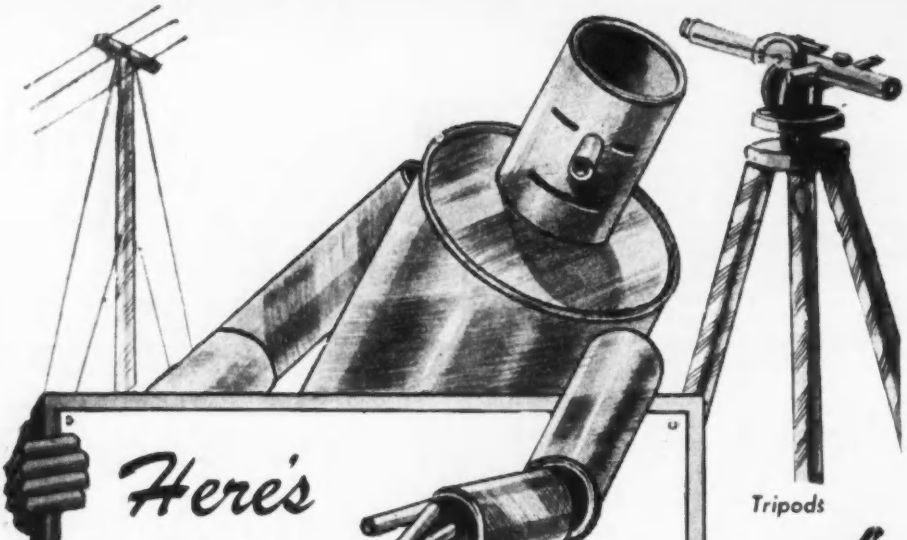


Radio Antenna Systems



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PLYTUBE is water proof — rot proof — splinter proof — weather proof — flame resistant and meets U. S. Army and Navy specifications AN-G8 or AN-NN-P511b.

Write today and we will be glad to help you adapt PLYTUBE to your specific requirements.

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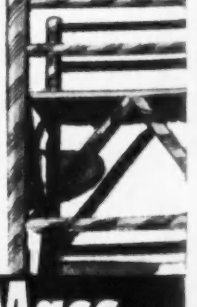

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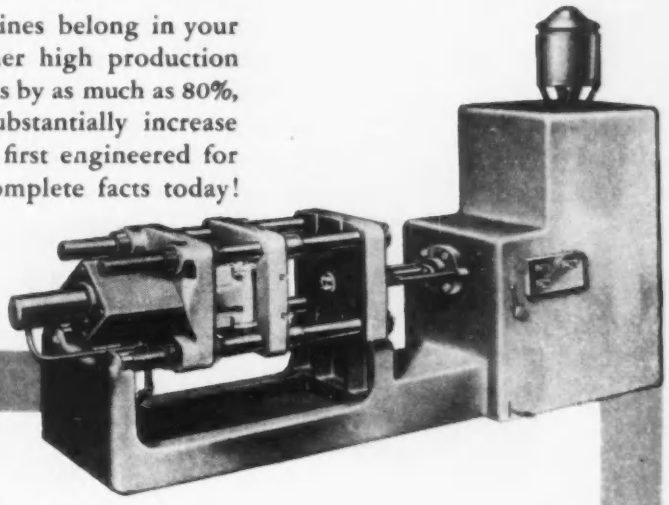
If you fabricate from metal, die casting machines belong in your production line, used as you would any other high production machine tool. You may cut machine operations by as much as 80%, reduce floor space as much as 90% and substantially increase production. The new Harvill machine is the first engineered for a production line installation. Write for complete facts today!



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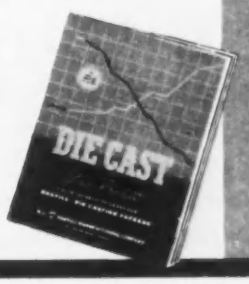
MEANS HIGHER PRODUCTION — LOWER COST

Are you *sure* your product is being produced at the lowest possible cost and at the highest rate? You *can't* be positive until you have fully investigated die casting . . . the shortest distance from raw material to finished product. Hundreds of case histories of conversion to die casting by "Red" Harvill have shown reductions in cost of as much as 90%. Such economies may be possible for you.

Send for "Package Plan" Brochure Today!

Every manufacturer should have a copy. Fully explains this sensational new production tool. Attach coupon below to your firm letterhead and mail today.



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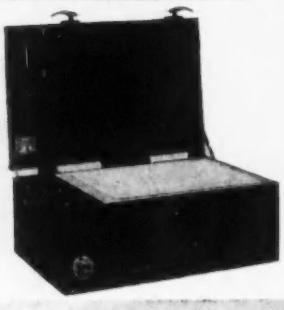
42" wide — in any length is the reproduction capacity of the G-13 Continuous Rotary Portagraph (left). Unsurpassed for making photo-copies of drawings, tracings, maps, blue-prints and for handling large volume copying.

30" x 40"—the G-12 Vacuum Seal Portagraph (right) is a dependable and indispensible piece of engineering office equipment. Ideal for making contact prints of anything written, printed or drawn. Also made in 40" x 60" size.

9½" x 15"— The G-10 Portagraph has innumerable everyday uses in engineering and other offices. Portable—can be set up anywhere. Electrical timing switch insures uniformly fine reproductions. For use with roll paper or cut sheets.



20" x 24"—Contact photo-copies are quick, easy, inexpensive to produce on the G-11 Portagraph. Electrical micro-matic timing switch insures perfect results with inexperienced operators.

Model G-9—size 9½" x 15"—equipped with manual timing control. An efficient general-purpose, low-cost unit, easy and simple to operate. Will copy from single page or bound book.

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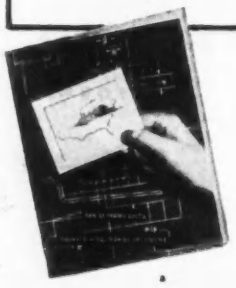

"How to Reduce Costly Manual Tracing, Drawing and Copying" contains many time-saving, labor-saving ideas for the engineering office. This helpful 20-page book of practical information is available free of charge from our nearest Branch Office. Phone, write or wire for a copy.

PHOTOGRAPHIC RECORDS DIVISION, REMINGTON RAND, BUFFALO 5, N. Y.

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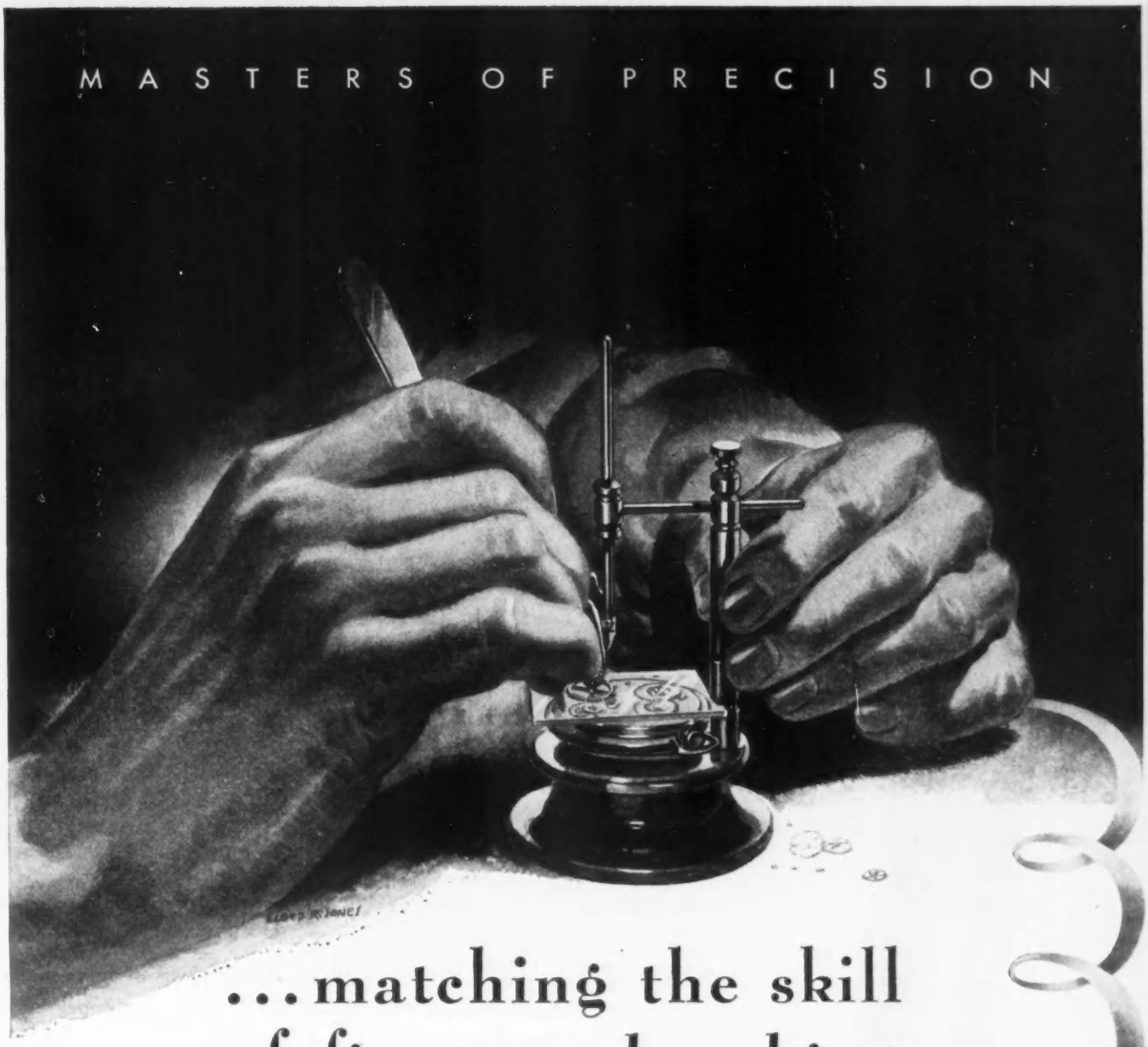

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Each step in producing Western brass or other copper base alloys requires the painstaking precision that is used in making timepieces of finest accuracy.

The temper you specify, the tolerances, the finish, will be supplied *as ordered*—in sheet, strip, long coils or stamped parts. Western mills at East Alton, Ill., and New Haven, Conn., *produce* that way.

We have the facilities, the experience, the skill, and most important, the *desire*. Those four factors comprise a valuable combination. That combination is faithfully serving America at war, but the capacity of Western mills is such that we may be able to serve you, too, now or later. Specify Western on your next order for copper-alloy metals.

Western BRASS MILLS

Division of WESTERN CARTRIDGE COMPANY, *East Alton, Ill.*

Western BRASS PRODUCTS

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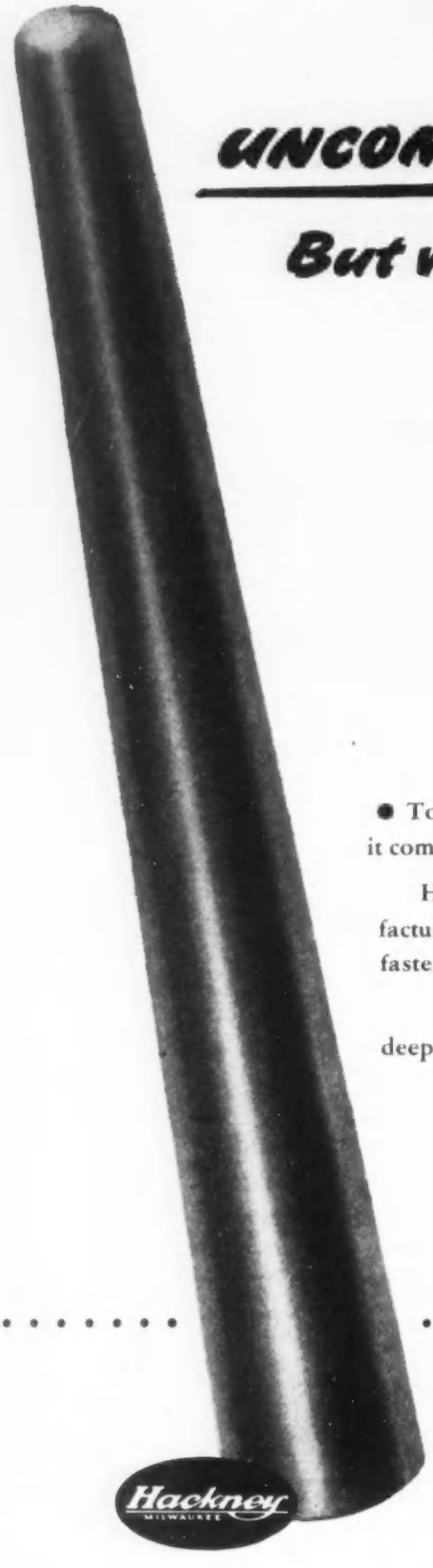
UNCOMMON SHAPES

But what have they in common?



● To look at, they're not at all alike—but they're just one big family when it comes to advantages.

Hackney Deep-Drawn Steel Shells have given the products of many manufacturers decreased over-all weight, increased strength, improved appearance, faster production, greater durability as well as other important advantages.

Pressed Steel Tank Company have been engaged in the manufacture of deep-drawn seamless shapes and shells for over 40 years. And they are made in capacities as small as one quart and as large as 110 gallons.

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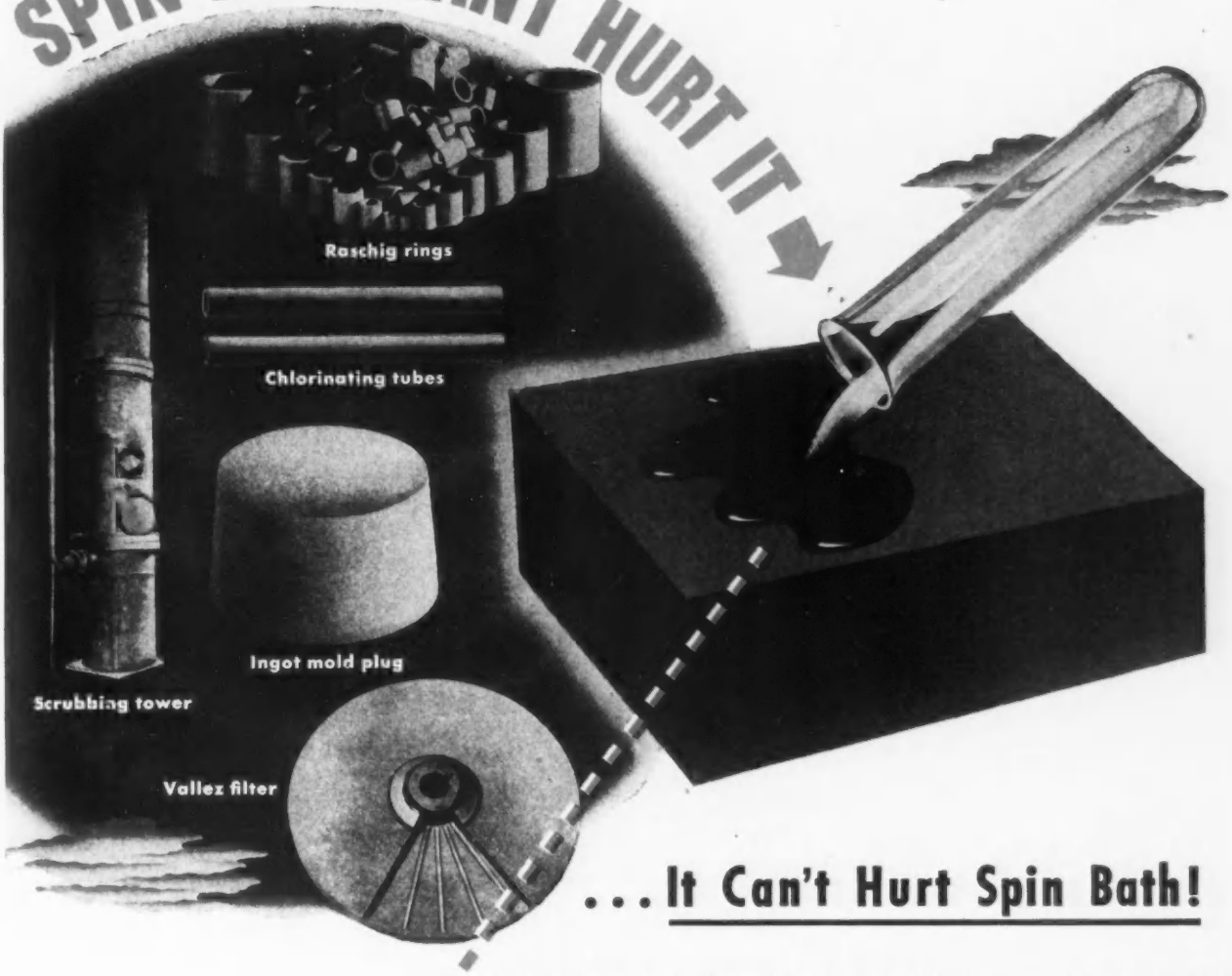
CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

SPIN BATH CAN'T HURT IT



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THAT'S just *one* tough problem in *one* industry . . . textiles . . . buttoned up! For acid spin bath solutions must stay pure—or else the delicate synthetic threads may be ruined. "Karbate" spin bath tanks and heaters* *safeguard* this purity!

The non-contaminating property of "National" carbon, graphite and "Karbate" materials solves problems like this in many industries . . .

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*Carbon or graphite made impervious to fluids under pressure.

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Carbon, Graphite, or 'Karbate' materials, of course!

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Unit of Union Carbide and Carbon Corporation

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It is really worthwhile to use a *permanent* tracing paper, for you never can tell when an old drawing may have to be consulted or reproduced. In many drafting room files there are drawings on ALBANENE that are years old, but are still in perfect condition, and should stay that way for 99 years or more. Protect your designs, your inventions, your business itself—use ALBANENE!

ALBANENE Tracing Paper is treated with Albanite, a crystal-clear, unaltering synthetic developed by the K & E Laboratories. So far as the most severe tests show, it should last almost forever. The paper itself is 100% white rag stock. The Albanite not only makes it ageless but extra transparent. And because ALBANENE stays white, it gives strong, contrasting prints. It's fine to work on too, with pencil or ink—keeps clean and takes erasures well. Comes in rolls, sheets, and pads. Write on your letterhead for sample sheet.

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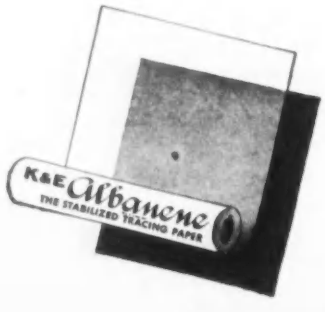

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KEUFFEL & ESSER CO.

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to 5/8" MAXIMUM O.D.

IN THESE METALS:

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Stainless Steels
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WELDRAWN: Stainless Steels, "Monel"

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Special tempers to your specifications

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FOR EVERY SMALL TUBING APPLICATION FROM 5/8" OD DOWN

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Before hands and tools and materials can give it shape, a Boulder Dam or a new plastics product must first exist in the minds of men who know how to think ahead of their times . . . and to translate their thoughts into practical action.

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Introducing "Control Gaging"—A New Technique

EXPERIENCE spot-lighted the necessity for gaging *at the machine* by which the operators themselves could quickly detect any tendency towards "out-of-control" running.

Setting go-no-go gages at the specified tolerance was ineffective. Studies resulted in development of a simple technique which we have called "control gaging."

This new technique, now used by Hunter on all control-charted operations, has proved very efficient. On short-run, close-tolerance jobs, where control charting cannot be effectively applied, control gaging obtains a degree of control comparable with long-run control-charted jobs.

In control gaging, the setting of the gages is determined by a simple mathematical analysis of samples from the machine. While running, the operator draws 5 pieces *produced in succession*, passes them through the control gage, and notes the number of failures at both limits. If, for example, *over* 2 pieces fail at the high limit the machine is running to the high side. A combination of low and high failures exceeding 3 pieces indicates the range has increased.

Suppose a machine is producing parts with a tolerance of ± .003". Now assume the machine setting shifts so that production is running + .004" — .002". The machine operator has only one chance in 44 of detecting the shift using conventional gage limits. Control gages, however, would definitely show the machine was off center through an increase in number of gage failures (beyond the 2 high max.) to 26% of the lots checked. The ratio of efficiency is at least 10/1 in favor of the control gage method.

THIS PROBLEM *posed in the last paragraph above is illustrated by the models below. The heights of the bars show the relative frequencies with which control gage limits are exceeded. Note the strong positive shift in these frequencies with off-center running. Control gage setting for sample size* $5 = \bar{X}' \pm .577\,\bar{R}$. *If you are not already acquainted with statistical methods for quality control we recommend that you promptly obtain copies of ASA Bulletins Z1.1-1941, Z1.2-1942 and Z1.3-1942 from the American Standards Association, 29 West 39th Street, New York, N. Y.*

NTER PRESSED STEEL COMPANY, LANSDALE, PENNA.

MINIMUM ★ "PERMANENT SET"

. . . Under Heavy Loadings and where Service Conditions are Severe

In the automotive, aviation and railroad fields,— as well as under anvils of forging hammers and many other types of machinery . . . where loadings are heavy and severe service conditions exist . . . FABREEKA absorbs impact shock and isolates vibration with MINIMUM "PERMANENT SET."

This is important,— being a principal reason why FABREEKA continues to give high efficiency after long periods of extremely hard use.

5 Principal Characteristics of **FABREEKA**

1 Limited Resiliency 2 High Damping
★ 3 Minimum "Permanent Set"
4 Great Strength . . . 5 Long Life

Product Engineers and Machine Designers are turning to FABREEKA to solve many problems in the absorption of impact shock and the isolation of transmitted vibration. Write for our Engineering Book: Fabreeka for Impact Shock, Vibration and Noise.

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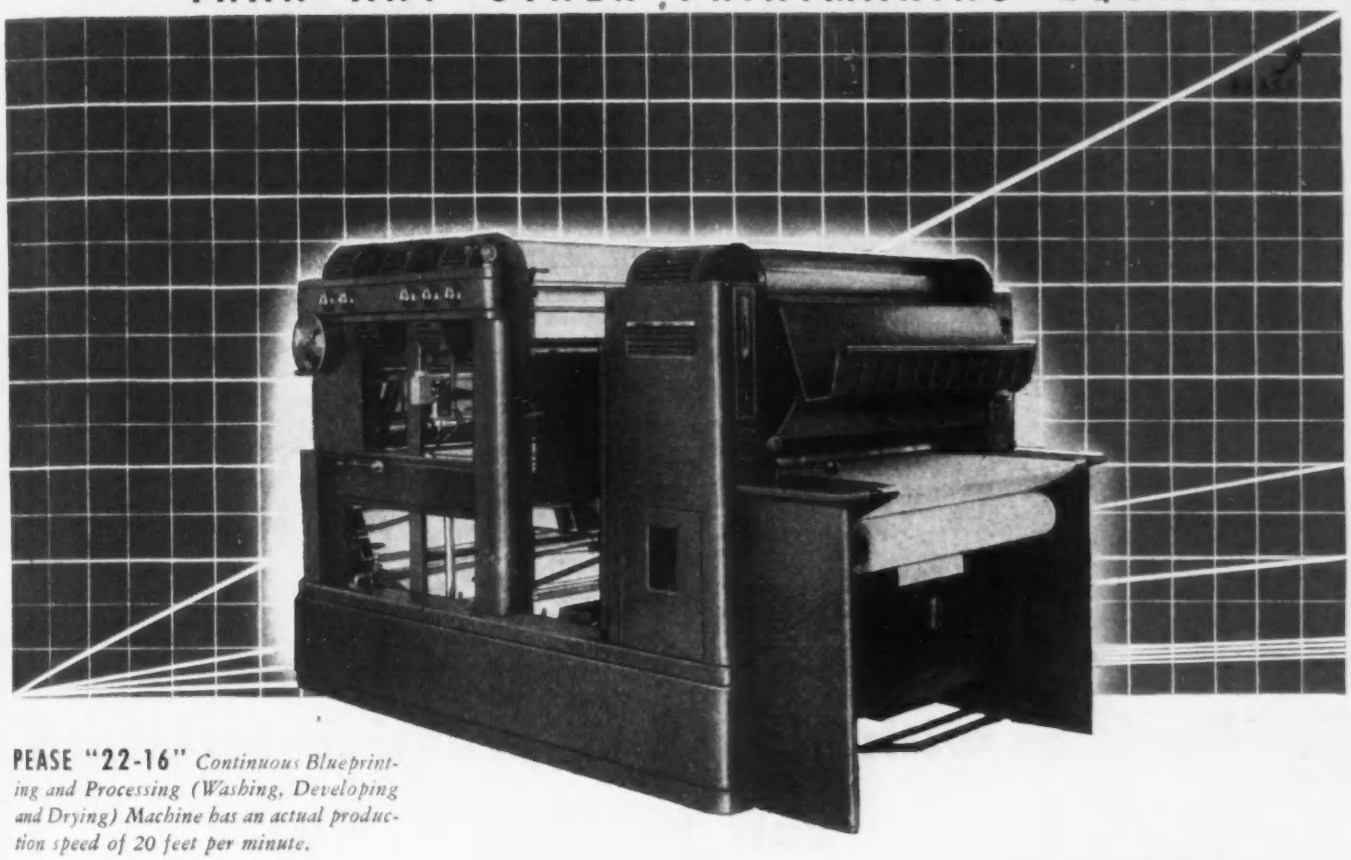
VIBRATION and IMPACT ABSORPTION MATERIAL

This Survey* Shows

MORE PEASE BLUEPRINTING MACHINES IN USE THAN ANY OTHER PRINTMAKING EQUIPMENT



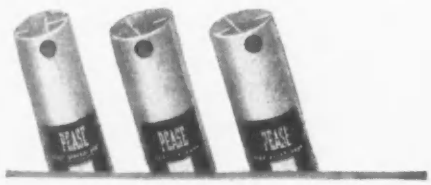
PEASE "22-16" *Continuous Blueprinting and Processing (Washing, Developing and Drying) Machine has an actual production speed of 20 feet per minute.*

PEASE PREFERENCE, by engineers and commercial blueprinters from coast to coast, is based on quality prints, economical operation, long life, trouble-free service, and fast production.

Pease Continuous Blueprinting and Processing Machines produce high grade prints at a speed of 30 feet per minute with Pease "22" (not shown) and 20 feet per minute with Pease "22-16" illustrated . . . The cost is extremely low—one cent (and even less) per square foot of finished blueprints.

Why not be guided by survey—let the tracing reproduction machines outstandingly preferred by users help you translate reconversion plans into realities.

**This survey was recently conducted by an independent organization, without our knowledge.*



PEASE SENSITIZED PAPERS . . . for use with any Blueprinting or Whiteprinting (Dry Direct Process) machines, are uniformly dependable for producing quality Blueprints, Blueline Prints, Brownprints (Negatives), Brownline Prints and Multazo Whiteprints.

Write for descriptive literature and prices today.

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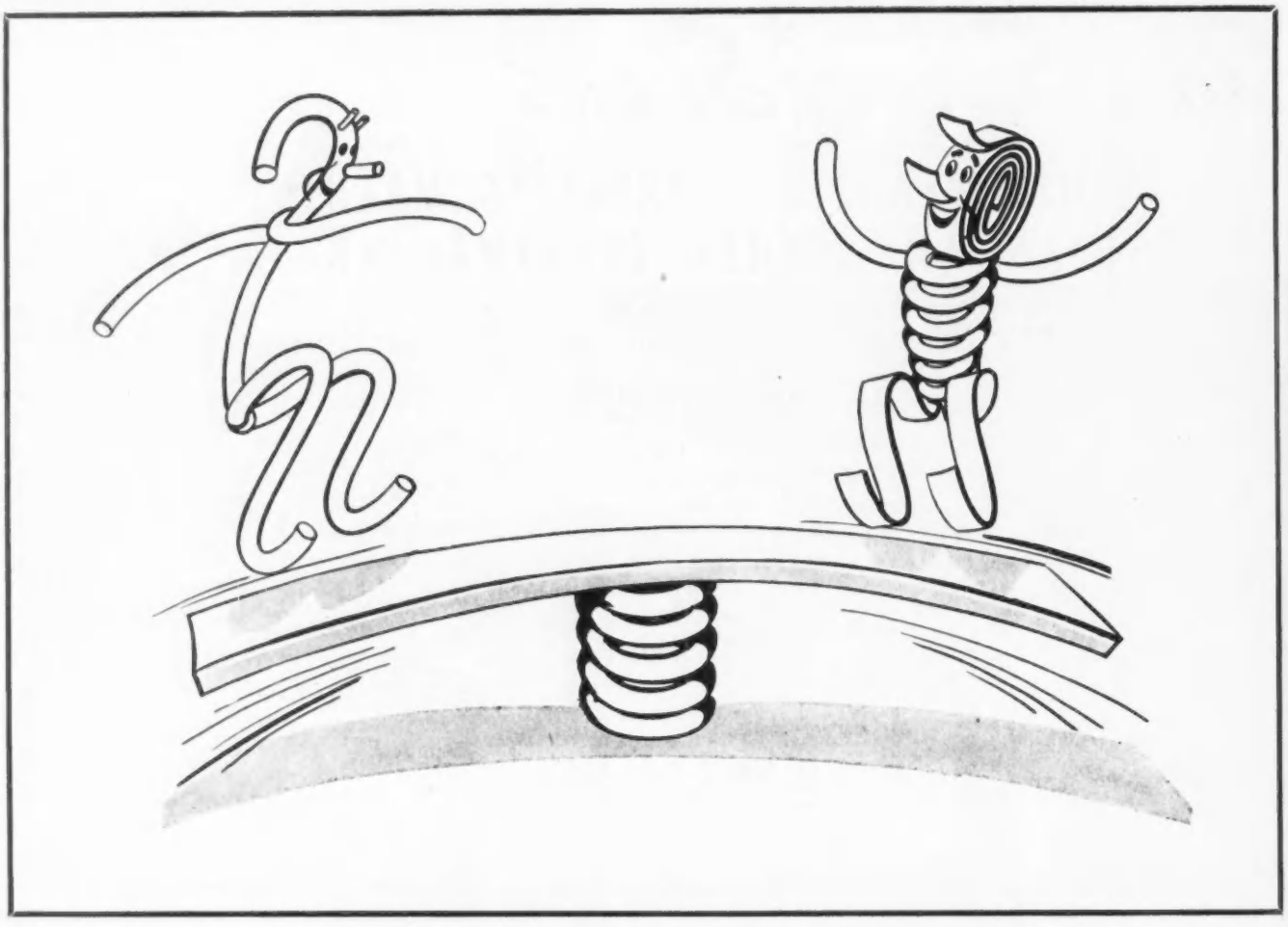
Pease Blueprinting Machines for all kinds of Tracing Reproductions



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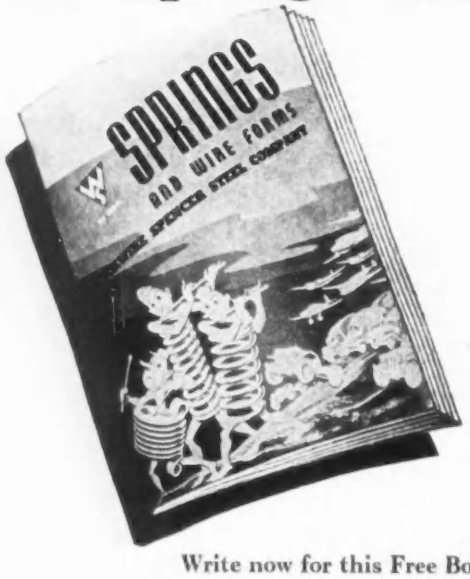

Write now for this Free Book

Our book "Springs and Wire Forms" gives valuable data relating to spring performance, technical information, formulae and tables needed to help in proper spring selection. For your free copy write Spring Division, Wickwire Spencer Steel Company, New Bond St., Worcester 6, Mass.

The wire in a helical compression spring is stressed in torsion. It is important, therefore, that the torsional strength of the wire be sufficient to carry the maximum load. Consideration must also be given to the dimensions of the spring—the amount of motion required and the properties of the material used.

Finding the answers to such problems is second nature to our experts Wick and Spen. For 124 years Wickwire Spencer has been helping to solve problems involving the use of wire and wire products. Our spring and formed wire specialists design every conceivable type of spring—and the steel we use is made in our own open hearths, drawn, formed, tempered and tested in our own modern mills.

If you are planning a post-war product involving the use of springs or formed wires, or if you have a question regarding springs, our engineers are ready to help you. Just write Spring Division, Wickwire Spencer Steel Company, New Bond St., Worcester 6, Mass.

WICKWIRE SPENCER STEEL COMPANY

EXECUTIVE OFFICES—500 FIFTH AVENUE, NEW YORK (18), N. Y.

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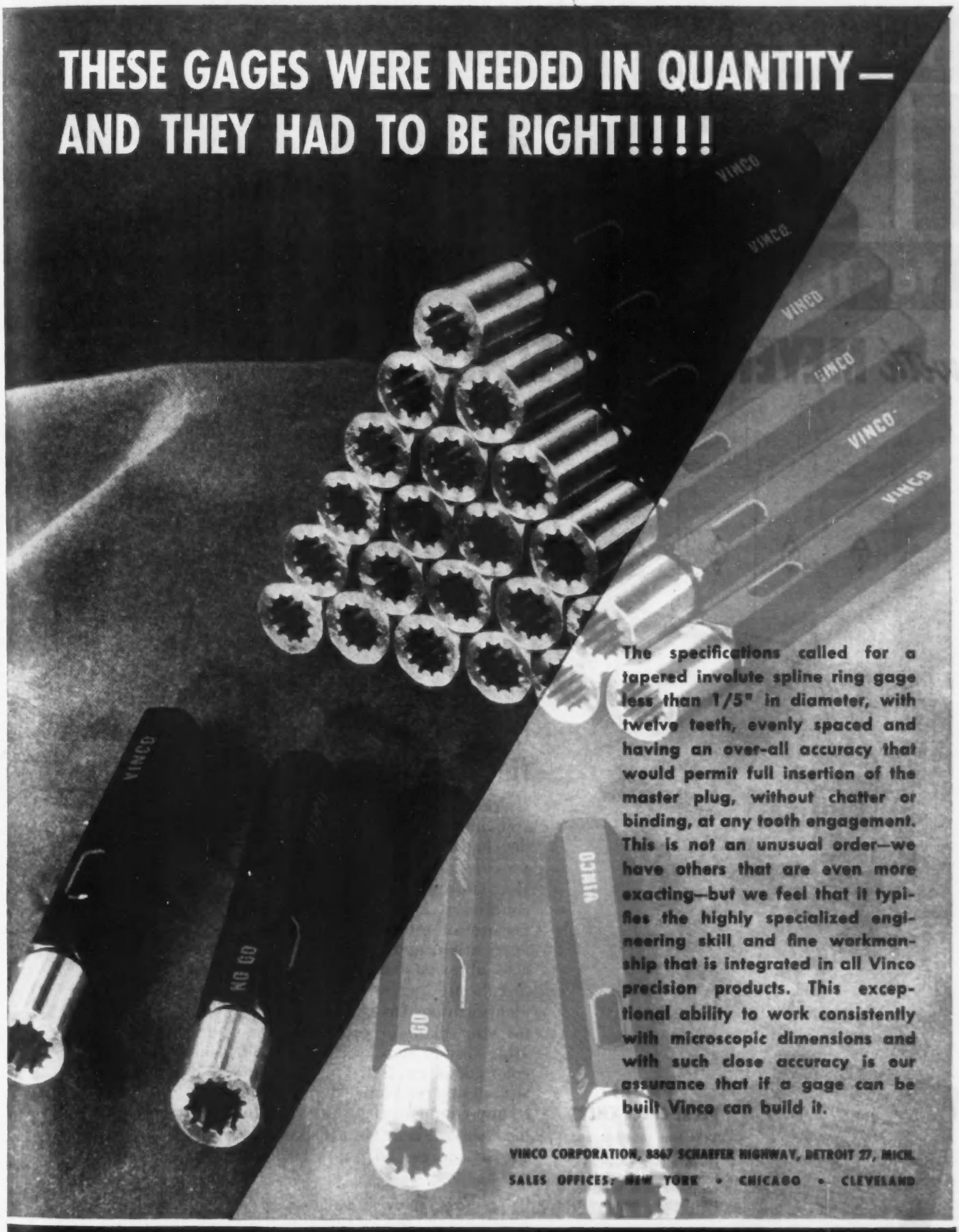
THESE GAGES WERE NEEDED IN QUANTITY— AND THEY HAD TO BE RIGHT!!!!



The specifications called for a tapered involute spline ring gage less than 1/5" in diameter, with twelve teeth, evenly spaced and having an over-all accuracy that would permit full insertion of the master plug, without chatter or binding, at any tooth engagement. This is not an unusual order—we have others that are even more exacting—but we feel that it typifies the highly specialized engineering skill and fine workmanship that is integrated in all Vinco precision products. This exceptional ability to work consistently with microscopic dimensions and with such close accuracy is our assurance that if a gage can be built Vinco can build it.

VINCO CORPORATION, 8367 SCHAEFER HIGHWAY, DETROIT 27, MICH.
SALES OFFICES: NEW YORK • CHICAGO • CLEVELAND

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Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Hub Gages • Built-up and Special Gages • Gear Railing Fixtures • Spline and Index Fixtures • Hydraulic Power, Control, Utilization and Distribution Units • Engineering, Design and Development.

the *RIGHT* oil

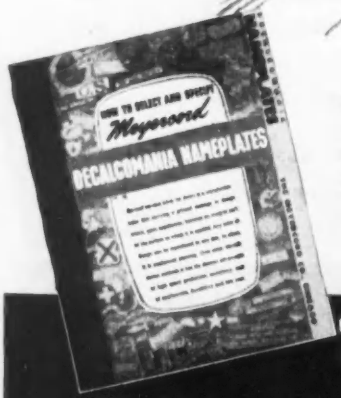
IDENTIFIED

for the *RIGHT* Job...

with MEYERCORD DECALS

Oil Company Uses Meyercord Decals for New Coded Lubrication System

By the use of matching numerals applied with decalcomania, an ingenious "Coded Lubrication System", developed by a nationally known oil company, now provides positive identification between all lubrication points...grease guns...oil cans...storage containers. Meyercord Decals are used throughout because of their brilliant, lasting visibility, ease of application, and resistance to oil, grease, vibration, acid, abrasion and temperature extremes. Meyercord Decals are the modern method for all nameplate identification. Investigate their flexible, low-cost use for your plant or product...for trademarks, operating instructions, wiring diagrams, factory charts, color codes, etc. They're washable and durable. Any size, design or colors can be produced for application to any commercial surface. Free designing and technical service is at your disposal. Write for literature. Please address all inquiries to Department **16-2.**



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DECAL CHECK CHART

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tested up to
1000° F.

Weirzin

ELECTROLYTIC ZINC COATED SHEETS AND STRIPS

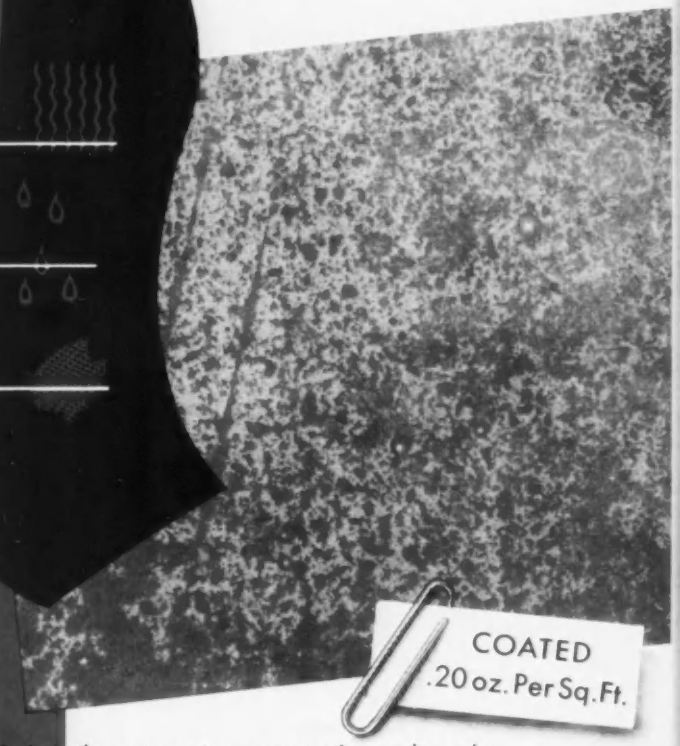
prove their resistance to

HEAT

MOISTURE

RUST

Try this test. 1000° F. for 60 minutes; cool specimen and repeat operation 4 times. Then subject samples to a saturated humidity at 100° F. and repeat after cooling . . . These unretouched photos magnified twice size show you what happens to Weirzin after such treatment—nothing but a slight and spotty discoloration—no flaking—no peeling—consequently no rust . . . All other materials tested failed.



Where high heat and humidity must be encountered Weirzin is the proved winner . . . Because of its exceptionally tight adherence of coating, Weirzin gives designers two outstanding advantages (1) A product that will not peel, flake or powder under high temperatures (2) An exceptionally ductile material that will take deep draws and severe fabrication without ordinarily requiring subsequent rust protection.

Weirzin is the answer to many service and production problems. It is available in coils or cut lengths, from ⅜ to 35" widths. Write for the Weirzin booklet and get the complete story of a product that offers you a substantial business advantage.

WEIRTON STEEL CO.

WEIRTON, W. VA. *Sales Offices in Principal Cities*

Division of **NATIONAL STEEL CORPORATION** *Executive Offices, Pittsburgh, Pa.*

Of course, it isn't technically a plastic, but it is so near to it that we use the term to emphasize its use possibilities. Through various chemical treatments we build into or upon a cloth structure the characteristics of a plastic joined with the flexibility, strength and fabricating possibilities of cloth. Any kind of cloth from a fine cambric to burlap.

Think of these materials as "flexible plastics" in helping to solve your post war material problems. Do not confuse these and other Holliston processes with ordinary cloth finishing. We prepare cloth with special characteristics to serve special needs — functional or decorative.

Consult our Research Department.

The HOLLISTON MILLS, Inc.

Processors of Cloth for Special Purposes

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Sales Agents in Principal Cities

Cloth Bound

A cloth bound book is bound to be kept — bind your

CATALOG — SALES MANUAL — INSTRUCTION BOOK, ETC.

in HOLLISTON Book Cloth — durable, impressive, hard-to-soil, easy-to-clean.

Write for samples.

Consult your printer.

SPECIAL FINISH

HOLLISTON special finish cloths meet special needs —

TRACING CLOTH — PHOTO CLOTH — RUBBER (PROCESSING) CLOTH — BOOK CLOTH — SHADE CLOTH — SIGN CLOTH — TAG CLOTH.

Cloth combined with special compounds, filled, impregnated, coated — to form a material with characteristics of a plastic and the flexible strength of a woven fabric.

Super-resistant

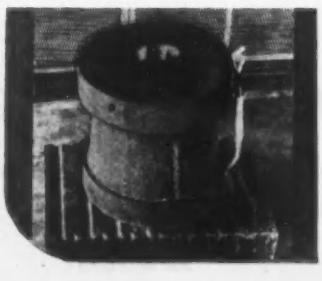
to Wear and Failure

Centrifugally-cast parts of Ampco Metal lengthen life of machinery...

Only from Ampco can you get *all* of these services and benefits:

1. Distinctive properties of resistance to wear, impact, fatigue, corrosion.
2. A series of engineered alloys — with physical properties to fit your application.
3. Quality control to hold these properties within narrow limits.
4. Diversified production facilities — coordinating in one place all the commonly used metal-working processes.
5. Engineering and production "know-how" to give you a practical manufacturing program.
6. A nation-wide organization of field engineers to assist you.
7. A record of proved performance in hundreds of leading makes of equipment.
8. A national reputation that makes Ampco Metal parts a sales asset.

To the basic advantage of Ampco Metal—its exceptional resistance to wear, shock, fatigue, and corrosion — the centrifugal casting process adds plus values. Cast under pressures 50 to 300 times as great as in sand casting, Ampco centrifugally cast parts are the practical equivalent of "liquid forgings"—100% sound (avoiding costly rejections), closer to finished size (saving metal). The Ampco organization furnishes all types of machining . . . rough, semi-finished, or ready for assembly . . . fabricated from an engineered alloy under close metallurgical control. . . . Let Ampco's broad facilities and experience play a constructive part in planning your post-war product. Write for bulletins and services of a competent field engineer.

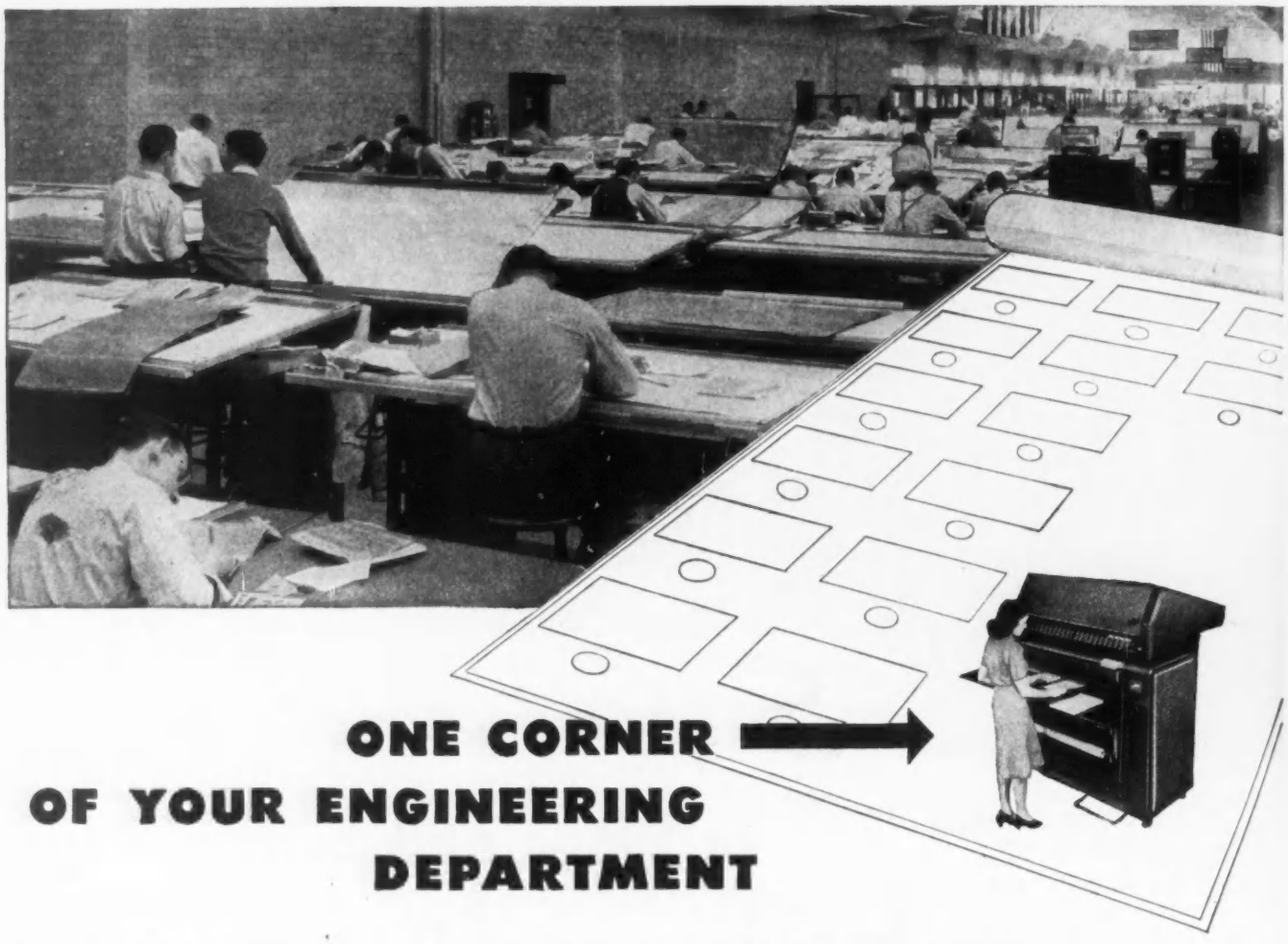


AMPCO Metal

Specialists in engineering, production, finishing of copper-base alloy parts

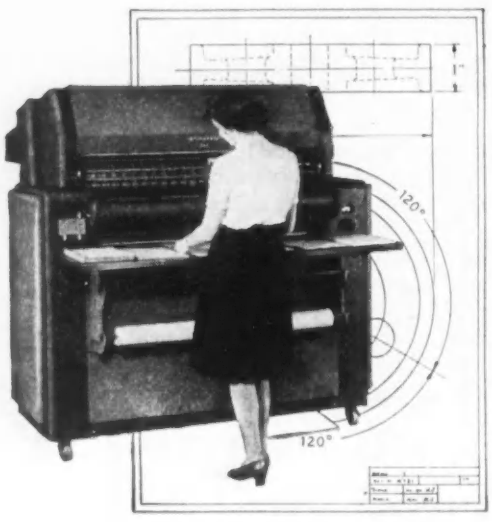
Ampco Metal, Inc.
Milwaukee 4, Wisconsin
Ampco Field Offices in Principal Cities

P.E. 2



ONE CORNER OF YOUR ENGINEERING DEPARTMENT

Is all you need to make Bruning Black and White Prints



• Have all the prints you want—exactly *where* you want them! No need for a separate "department" when you make Bruning Black and White Prints! Simple, compact Bruning BW equipment—like this 75-159B BW Printer-Developer—easily fits into your engineering department or drafting room—needs no plumbing. This machine gives you big-volume production with *one* operator. BW Prints, too, are made faster than blue prints—there's no washing and prints are delivered ready for use. No matter how many—or how few—prints you use per day, there is Bruning BW equipment to fit your needs. Mail the coupon for complete information.

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Please send me your free booklet giving up-to-date information on Bruning Black and White Prints. I understand there is no obligation.

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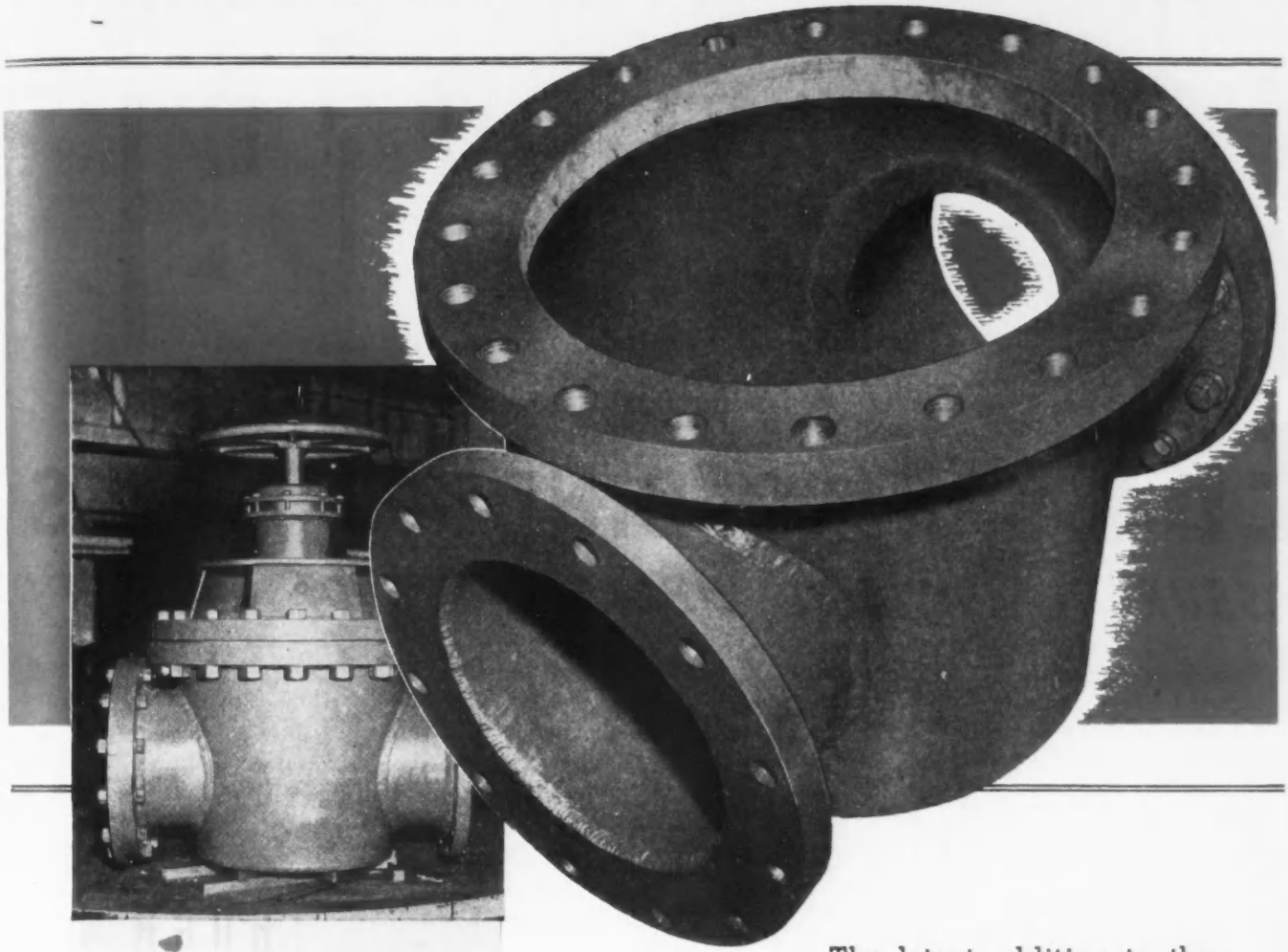
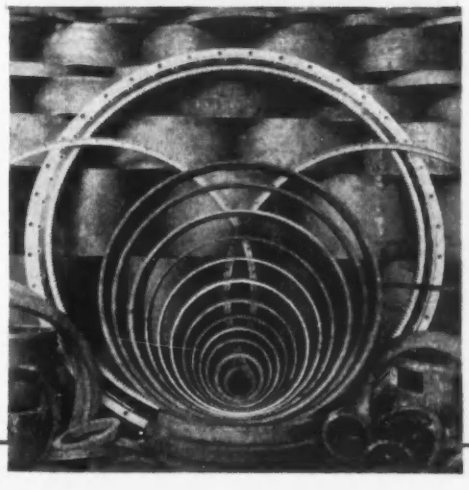
FABRICATED BY WELDING



American Welding engineers will gladly give you the benefit of their experience. A consultation may bring to light unheard of possibilities when American ingenuity is put to work. We invite your inquiry, it will receive prompt attention without obligation.



The latest addition to the many weldments engineered and produced by us is a 12" pipe valve body. Six resistance welded steel rings, assembled by arc welding, complete a unit 31" wide and 21½" high.

Our facilities and experience enable us to efficiently produce quality products from the simplest welded steel rings, diameters from 4" to 8', thicknesses from 1/4" to 3", to weldments that include hundreds of pieces.

THE AMERICAN WELDING & MFG. CO.
WARREN, OHIO

AMERICAN WELDING
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BY RESISTANCE, ARC OR GAS WELDING

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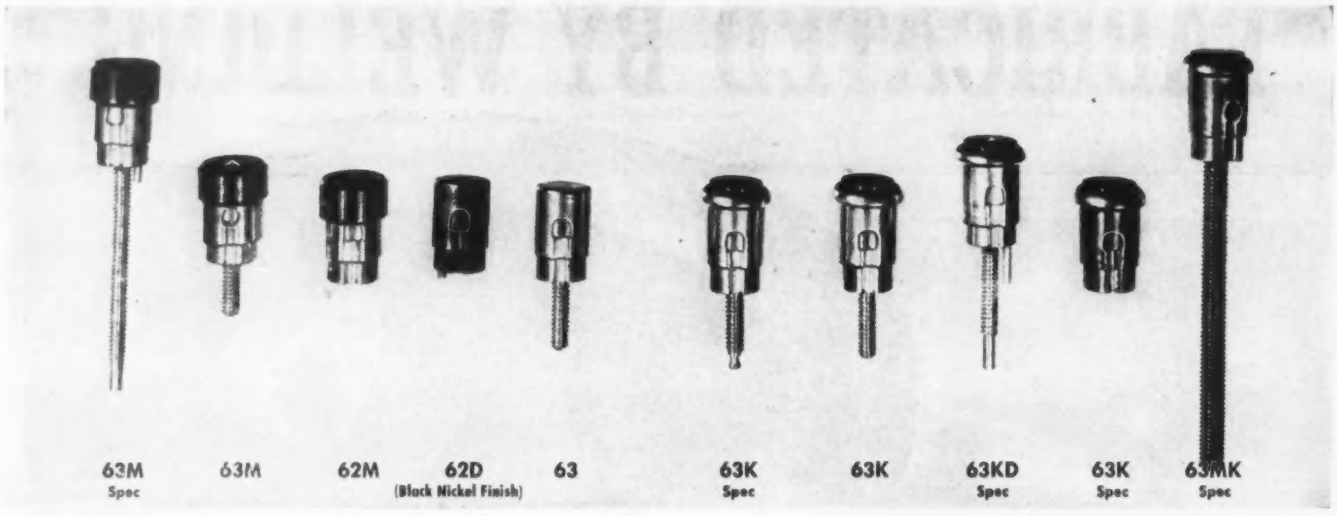


EBY SPRING BINDING POSTS

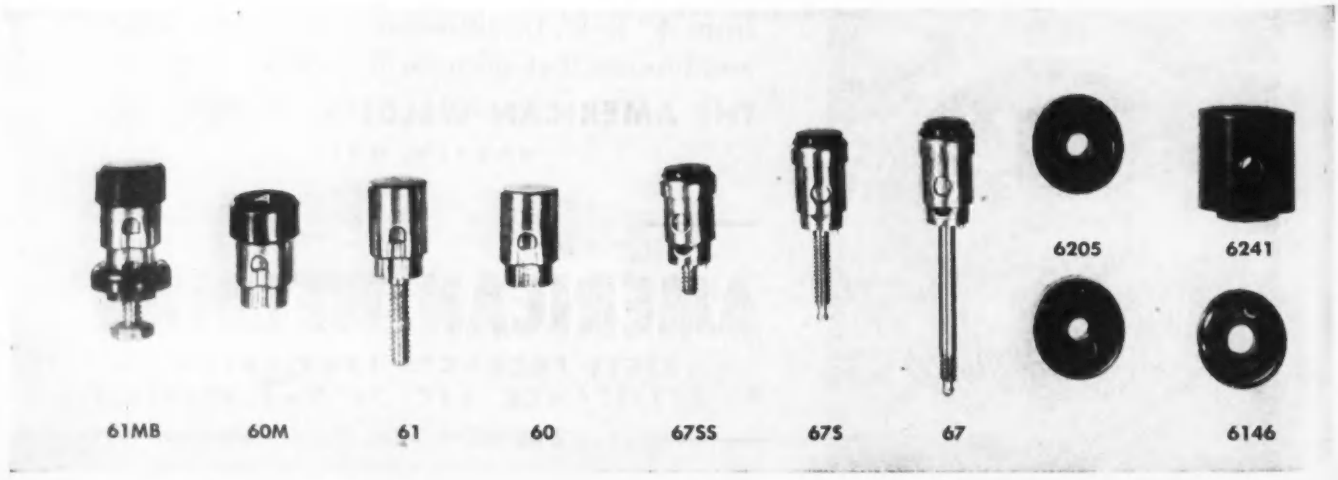
ASSURE A POSITIVE VIBRATION-PROOF CONTACT!

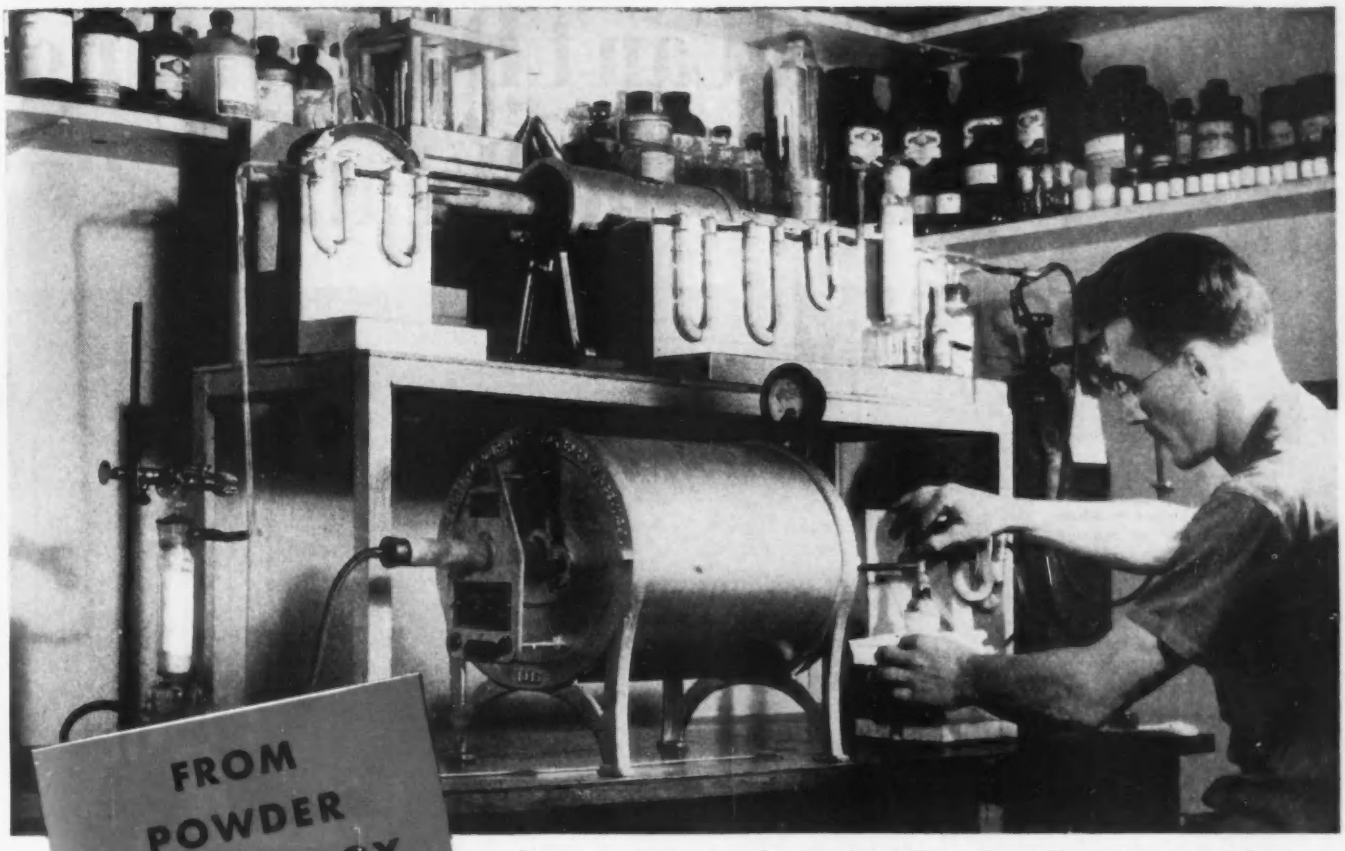
1. The spring — unseen but most important, is designed for long life with minimum pressure loss in service — corrosion resistant.
2. The "D" shaped hole grips the finest wire and holds it in perfect contact. This special Eby construction gives correct, uniform tension across the entire surface of the wire.
3. Eby spring posts have dual guides — makes positive alignment of insertion holes.
4. Made from the highest quality material to meet rigid manufacturing standards and assure maximum electrical conductivity.
5. Recognized standard finishes are nickel, silver, black nickel, and cadmium.
6. Insulating bases, shields, bushings, and spacers in bakelite and ceramic.
7. Cap markings are supplied such as: ANT; REC; GND; HI; A; C; Line; —; +; L1; L2.
8. Most items are carried in stock in sufficient quantity to assure quick preliminary deliveries.

Eby Spring Binding Posts are made to a traditional standard of quality and workmanship, backed by years of experience and a long list of satisfied users. The actual styles shown are illustrative of the wide variety and the great possibility of the use of Eby Spring Binding Posts.

A BINDING POST FOR EVERY USE!

HUGH H. EBY
INCORPORATED
18 W. CHELTEN AVE.
PHILADELPHIA 44, PA.





This unique apparatus, developed in The S. K. Wellman Company laboratories, measures minute quantities of oxygen in powder metal formulas.

FROM POWDER METALLURGY HEADQUARTERS

. . . come better friction materials

● In the world's largest laboratory devoted to friction materials, we are constantly finding ways to produce *better* clutch facings and brake linings. That's why Velvetouch has established so many enviable records for long wear and smooth operation in all types of earthmoving, automotive, industrial and machine tool equipment. Be sure to specify this all-metal friction material in your next clutch or brake design.

THE S. K. WELLMAN COMPANY
1374 EAST 51st STREET • • CLEVELAND 3, OHIO

Velvetouch is *all metal*—a combination of powdered metals, compressed, sintered and welded to a solid steel backing.

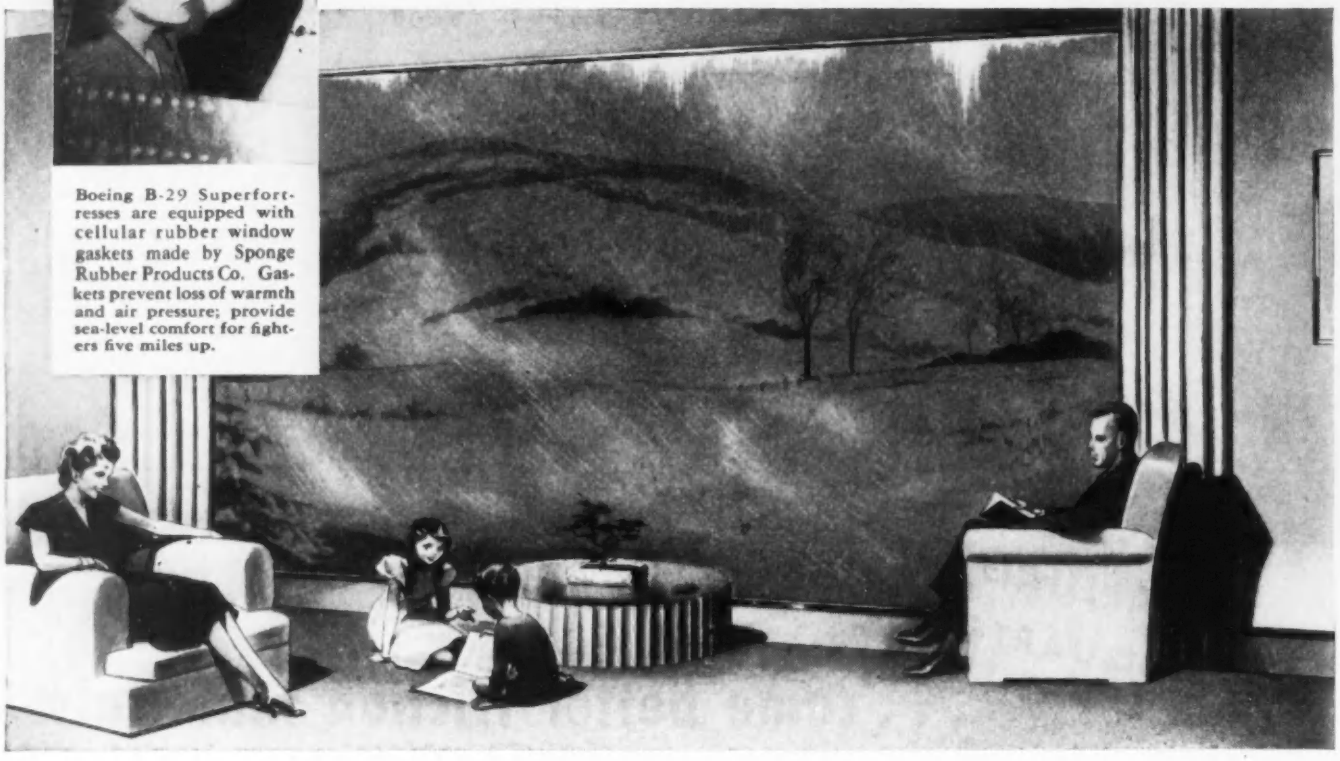
For Brake and Clutch . . . Use Velvetouch

The "INSIDE STORY" of POWDER METALLURGY

CHAPTER II. For maximum strength and heat conductivity, the powdered metal friction materials are firmly bonded to steel backing plates. Photo above shows steel "cores" being stamped out for Velvetouch facings.

Who says "You Can't Do Anything About the Weather"?

Boeing B-29 Superfortresses are equipped with cellular rubber window gaskets made by Sponge Rubber Products Co. Gaskets prevent loss of warmth and air pressure; provide sea-level comfort for fighters five miles up.

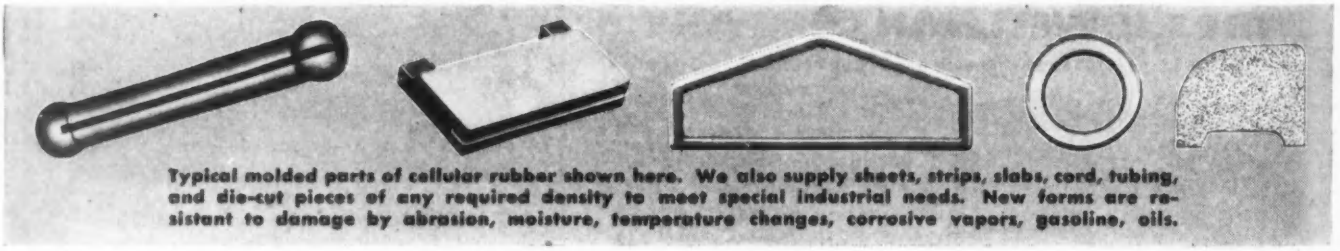


HE's wrong. You can. It is being done now in combat equipment: planes, trains, ships, ambulances, buses, automobiles. They carry good weather with them wherever they go.

Molded cellular rubber gaskets, tested in the 40-below zero cold of the stratosphere will shut out cold or heat, smoke, dust, and irritating pollens. They'll seal the picture window of your living room; lock tight the door of your 300 m.p.h. plane. Wherever there is a problem of sealing, sound deadening, vibration dampening, insulation, or cushioning, this versatile light weight material will cut costs, speed production, step up usefulness.

Production Capacity Available Now
Most of our production is devoted to cellular rubber parts for planes, ships, jeeps, trucks, tanks and other combat equipment: also materials for other industrial plants in war production. Let us help you *now* with your war work.

Hundreds of different shapes and forms can be made to order. Soft Spongex* with interconnecting cells and soft and hard Cell-tite* with non-connecting cells are compounded and molded to meet your specific needs – whether it's a small part to add salability to a household appliance, or a complicated gasket for an automotive assembly. 21 years continuous experience with cellular rubber have readied our staff for your toughest problems. We're all set to work with you now. Write, wire or phone for further information.



Typical molded parts of cellular rubber shown here. We also supply sheets, strips, slabs, cord, tubing, and die-cut pieces of any required density to meet special industrial needs. New forms are resistant to damage by abrasion, moisture, temperature changes, corrosive vapors, gasoline, oils.

Sponge Rubber Products Co.

123 Derby Place, Shelton, Conn. • Plants in Derby and Shelton, Conn.

***Sales Offices:* New York • Chicago • Washington • Detroit**

WORLD'S LARGEST MANUFACTURERS OF CELLULAR RUBBER AND BONDED FIBRE PRODUCTS

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is a service . . .

As Well As A Complete Line Of Thermosetting Plastics!

PANELYTE is more than a trade-name for a wide range of structural laminated resinous plastics. The mass-production of sheets, rods, tubes, molded forms and fabricated parts — research and engineering accomplishments . . . plus accumulated application knowledge—adds further significance to the name. The sum-total is expressed in PANELYTE Service . . . from coast-to-coast!

Come to PANELYTE for reliable, up-to-the-minute information on the use of thermosetting plastics. Ask us *if* and *how* laminated plastics can be employed to produce better structural and insulating parts for you — in less time — and at lower cost. PANELYTE engineers, familiar with properties, advantages *and* limitations, can recommend the specific grade best suited to a given application. Their design advice can prevent costly errors. Efficient, straight-line production assures adherence to specifications and prompt deliveries.

Avail yourself of PANELYTE Service by giving us detailed information on the design and use of the part in question.

Write for factual Data Book!

PANELYTE *the structural plastic*

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ST. REGIS PAPER COMPANY
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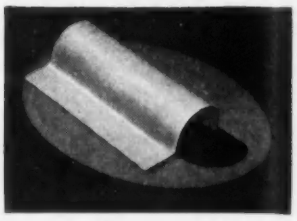
Sales Offices: Atlanta, Boston, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, Mexico City, Montreal, New Orleans, Phoenix, St. Louis, St. Paul, San Francisco, Seattle, Syracuse, Toronto, Trenton, Vancouver

* MASS PRODUCTION OF SHEETS, RODS, TUBES, MOLDED FORMS, FABRICATED PARTS IN PAPER, FABRIC, FIBRE GLASS, WOOD VENEER AND ASBESTOS BASE LAMINATES

Large parts... or Small...



This tiny strip of resin-impregnated duck is only 3½ inches wide and is low-pressure molded in lengths up to 20 feet.

readily produced by Weldwood low-pressure molding

THE photo above shows a large size unit recently molded by our Algoma, Wisconsin plant.

Measuring 26 feet in diameter by 7 feet 5 inches in height, this interesting example of Weldwood low-pressure molding utilizes fiber glass skins with special filler inserts. It was made in twelve sections and is the top part of a completely molded structure, 22 feet high by 26 feet in diameter. Light in weight, exceptionally strong, it has unusual dielectric qualities.

Experience in this type of fabrication convinces us that low-pressure molding of both large and small parts will answer many of Industry's post-war problems of design and production. Especially where large units are required in small volume, Weldwood low-pressure molding is fast and economical.

New materials, new combinations of old materials, new production techniques have been developed by United States Plywood Corporation, and are at your disposal. Our research staff would like to work with you.

If you are interested in plywood—for any purpose—you will find the greatest variety under the Weldwood trademark. Present production includes the following types of plywood and plywood products:

Douglas Fir	Tempered Tekwood*	Armorply* Weldwood
California Pine	Northern Hardwoods	Low pressure plastics
Molded Weldwood	Southern Hardwoods	Tempreg*
Tekwood*		

*Registered trademarks

Weldwood

WELDWOOD Plywood

UNITED STATES PLYWOOD CORPORATION

World's Largest Producers of Plywood

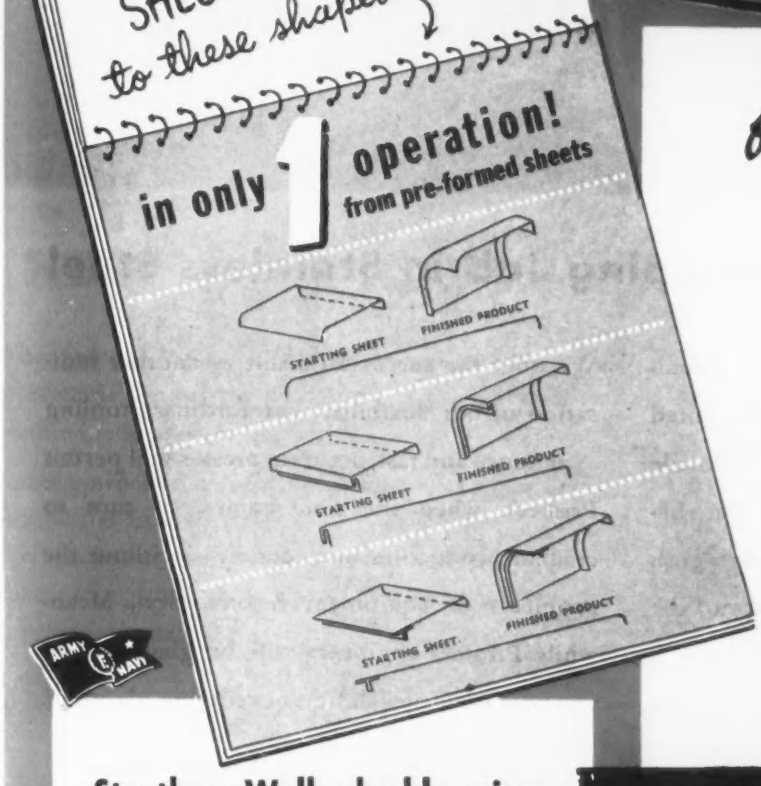
616 West 46th Street, New York 19, N. Y. Branches in Principal Cities

Struthers Wells introduces the . . .

SW New SINGLE WING Tangent Bender

U. S. Patent
No. 2,287,933
Other Patents Pending

Tangentially and smoothly edge bends SHEET METAL to these shapes



Struthers Wells double wing TANGENT BENDER

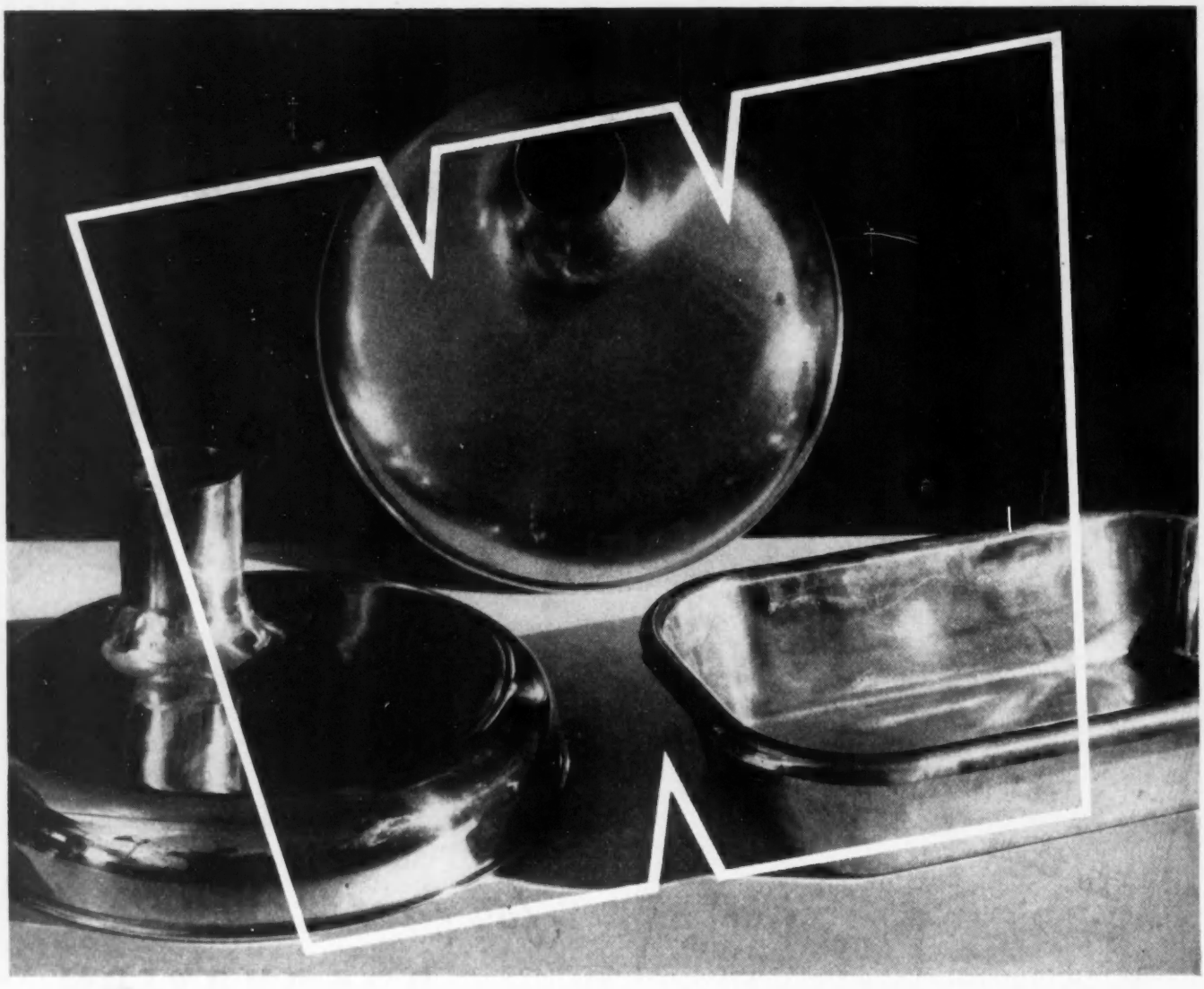
A heavy duty hydraulic machine for greater production. Fully described in Bulletin No. 53-T.

for fast, economical
PRODUCTION

Struthers Wells Single Wing Tangent Bender has been designed for applications requiring more frequent die changes and shorter runs. It provides tangent bending to *precision-tolerance,* greatly increased production on difficult operations—with fewer expensive man-hours. This hydraulically operated machine is also an improved brake. *Tangent bending* should enable you to produce better and more economical metal furnishings . . .

Write for Bulletin No. 57-T

STRUTHERS WELLS CORPORATION
SPECIAL EQUIPMENT DIVISION
TITUSVILLE, PENNA.
Plants at Titusville and Warren, Pa.—Offices from Coast to Coast



An Unusual Stamping Job in Stainless Steel

For sanitary reasons a certain prominent manufacturing company wanted these parts for meat grinders made in single-piece stampings. But, because it is quite a trick in stainless steel to push through a neck off center like this and curl the edge, the only solution that was offered was a two-piece welded job—until the company put the problem up to Presteel.

We offer the successful result as another indication of our flexibility. Extraordinary tooling experience and fast, accurate presses will permit Presteel, when the time comes, to turn to civilian production immediately — without the problems of equipment reconversion. Meanwhile Presteel engineers will be glad to help you with your new design or redesign planning. Write to

WORCESTER PRESSED STEEL CO.

702 Barber Avenue, Worcester 6, Mass.

ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883

HERE'S A PICTURE OF LICKED LIMITATIONS

When you look at a small part by Pomet, you usually see an example of how the limitations of conventional production methods were overcome.

Pomet powder metallurgy opens up a whole new field of possibilities in the fabrication of small parts in bronze, iron, steel and other metals. It widens the scope for designers of wartime products and promises new economies in peacetime production.

If you need dense, intricate parts in quantity, it will pay you to learn more about the new Pomet techniques.

Special characteristics like hardness, ductility, wear resistance and tensile strength can be incorporated to order. Machining is either entirely eliminated or reduced to a minimum.

We will be pleased to quote on blueprints or specifications, or send you literature on request.

CLOSE TOLERANCES
WITHOUT MACHINING

HIGH DENSITY

POMET

DUCTILITY OR HARDNESS
COMBINED MATERIALS
WEAR RESISTANCE

POWDER METALLURGY CORPORATION

A SUBSIDIARY OF GENERAL BRONZE CORPORATION

30-48 Greenpoint Avenue **Long Island City, N.Y.**

Your POSTWAR METAL PRODUCT / designed and engineered NOW!

★ Plan NOW to enlist the aid of GRAMMES Contract Service to develop ideas and blueprint your postwar metal product. The stove trim illustrated is but one of the recent achievements of our designers and engineers . . . other postwar product developments include several radio units, soft drink dispenser, new type snap locknut, parts for refrigerators, giftware, and other consumer and industrial products. These assignments indicate the versatility of our product development staff and how they have assisted others in accomplishing the desired end result.

Since 1875 GRAMMES has collaborated with manufacturing leaders . . . automobile, aviation, radio, refrigerator, and other key industries . . . in creating metal products of distinction. We are specialists in giving products the sales-creating features that flow from "above average" design and decorative beauty of color.

With two "E" awards, we're producing for Victory, but our Contract Service offers Research, Design, and Engineering aid NOW. Improved production techniques and increased plant facilities enable us to handle a few additional accounts requiring volume production for eventual postwar manufacturing.

GRAMMES FACILITIES INCLUDE

Stamping, Drawing, Spinning, Etching, Embossing, Lithographing, Enameling, Hard Enameling, Plating, Spraying, Wire Forming, Drilling, Welding, Machining, Heat Treating, Anodizing (Alumilite), Tools & Dies and Line Assembly.

Send for booklet describing "Contract Service by Grammes".

Grammes

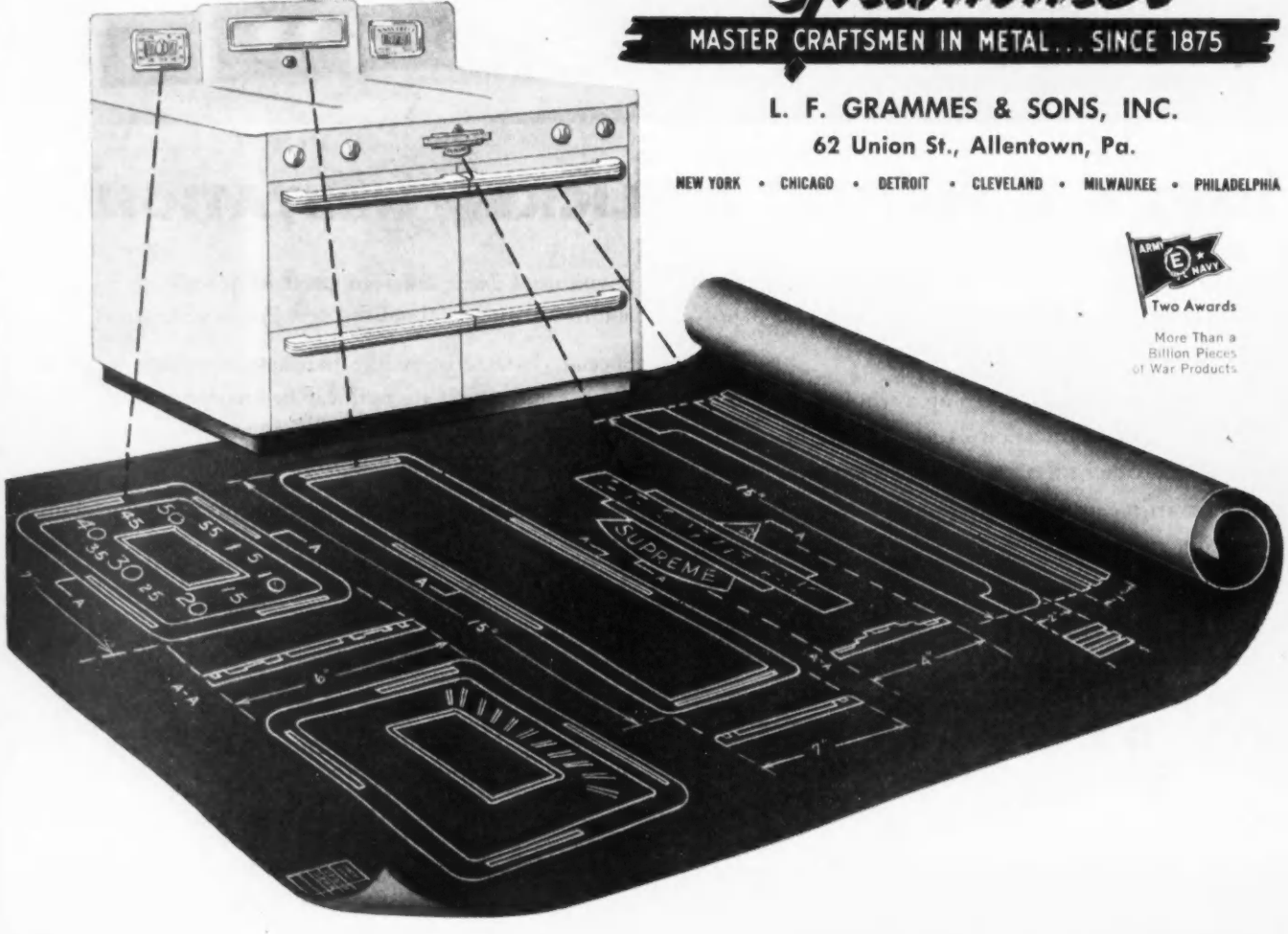
MASTER CRAFTSMEN IN METAL... SINCE 1875

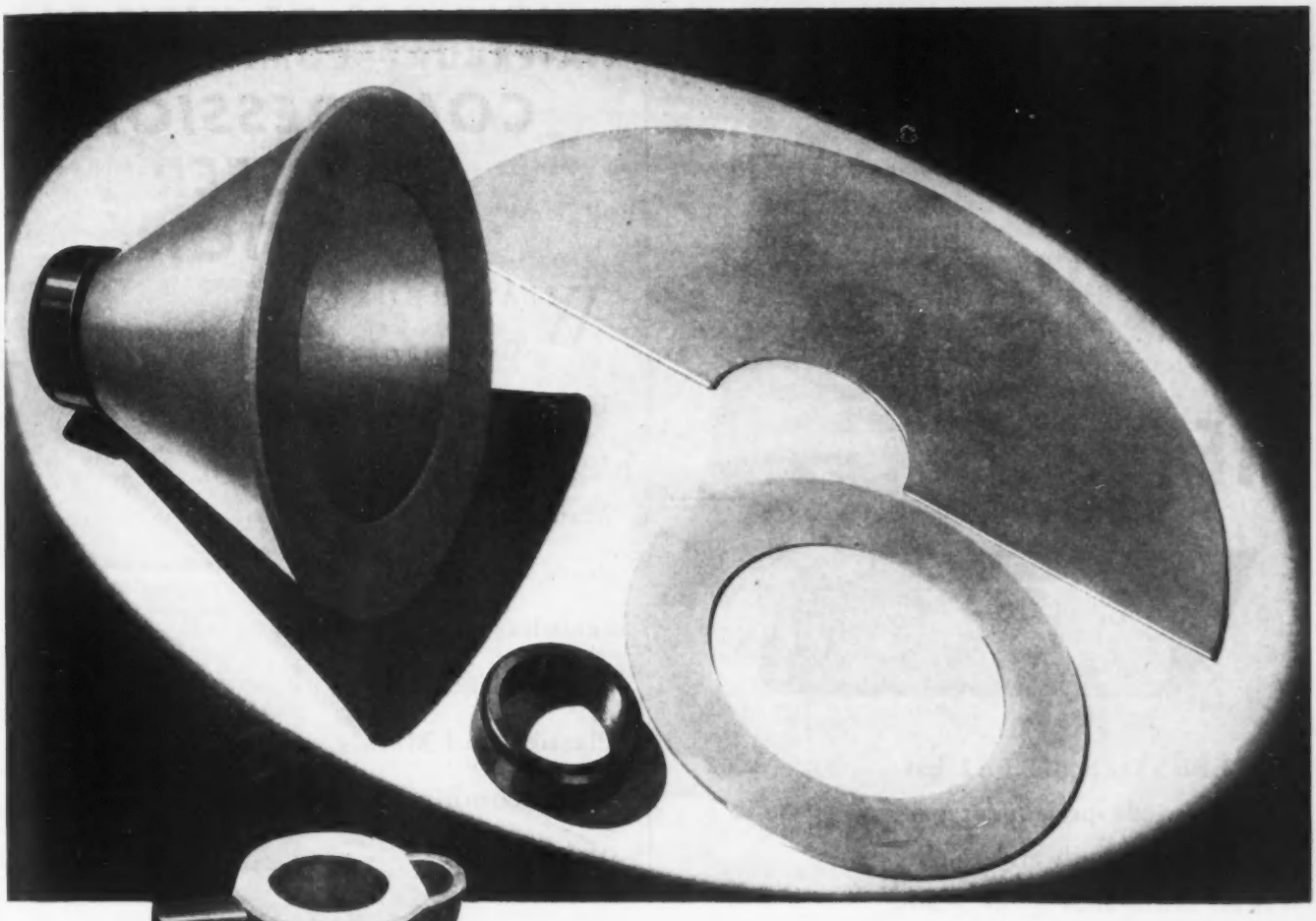
L. F. GRAMMES & SONS, INC.

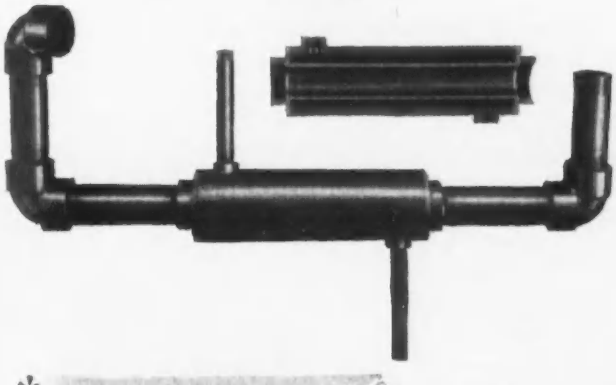
62 Union St., Allentown, Pa.

NEW YORK • CHICAGO • DETROIT • CLEVELAND • MILWAUKEE • PHILADELPHIA

ARMY E NAVY
Two Awards
More Than a Billion Pieces of War Products







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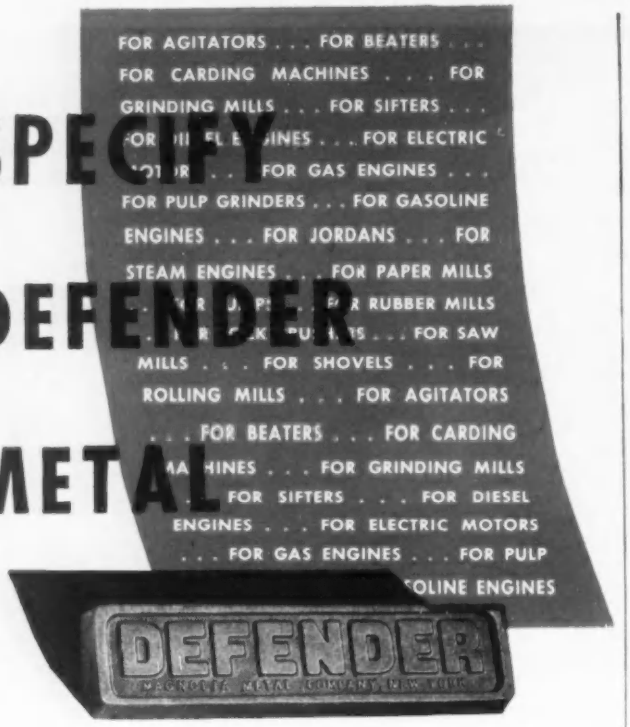
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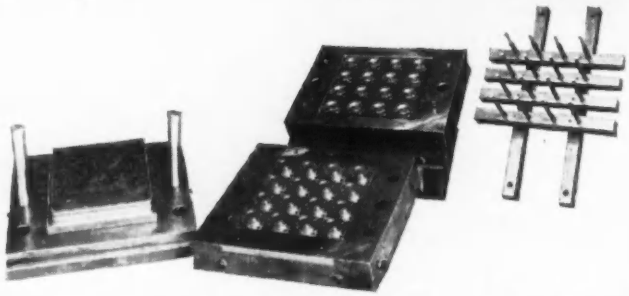

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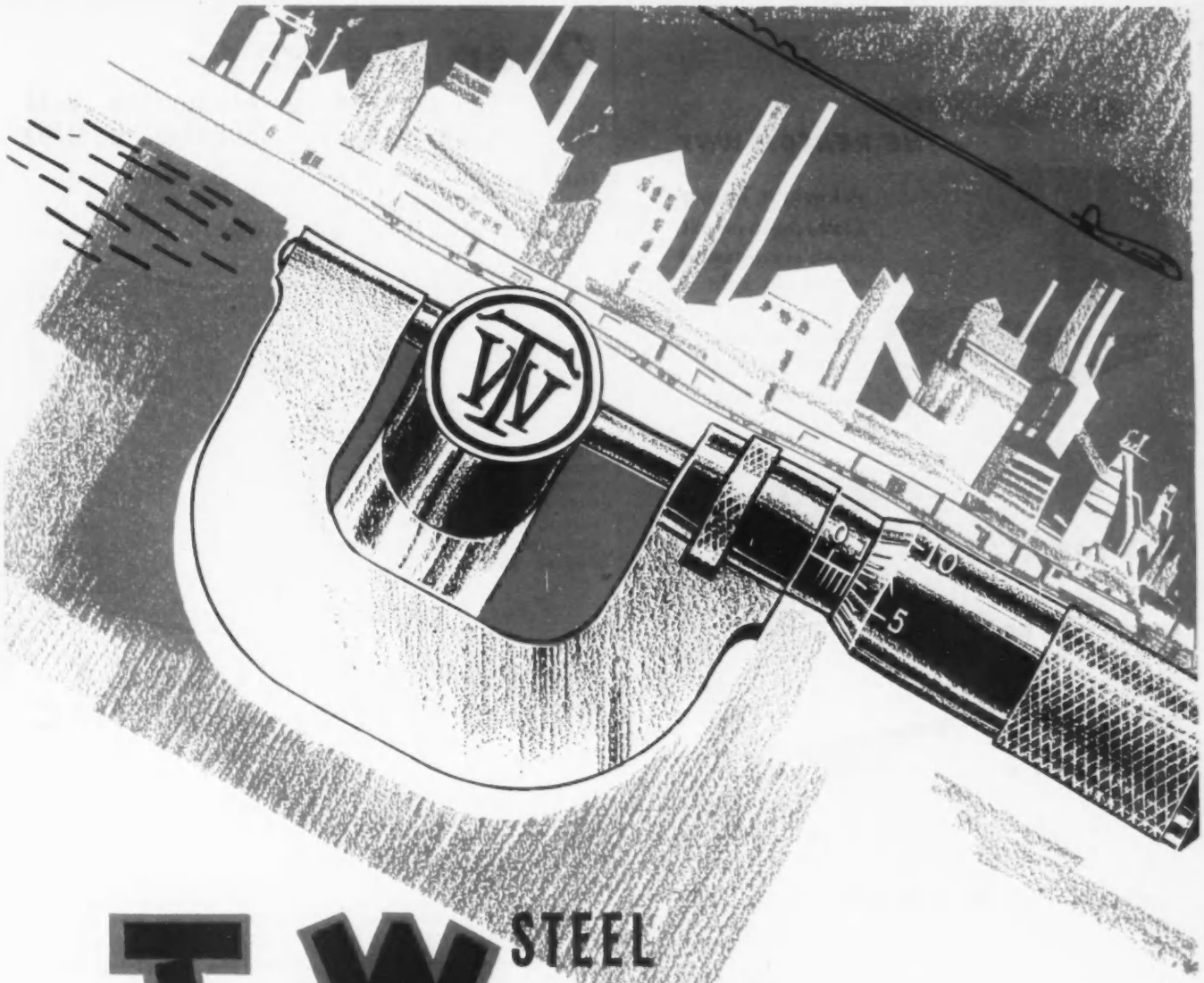

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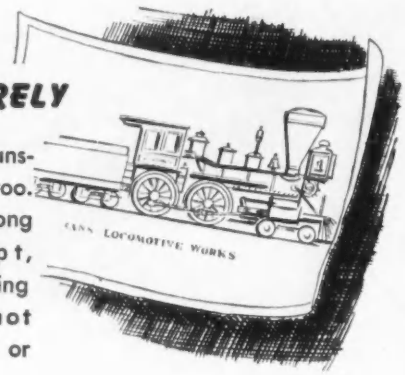

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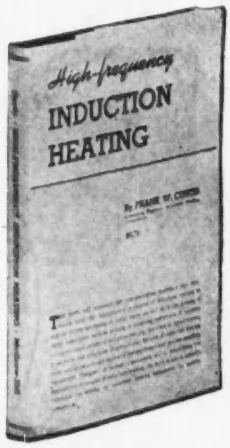

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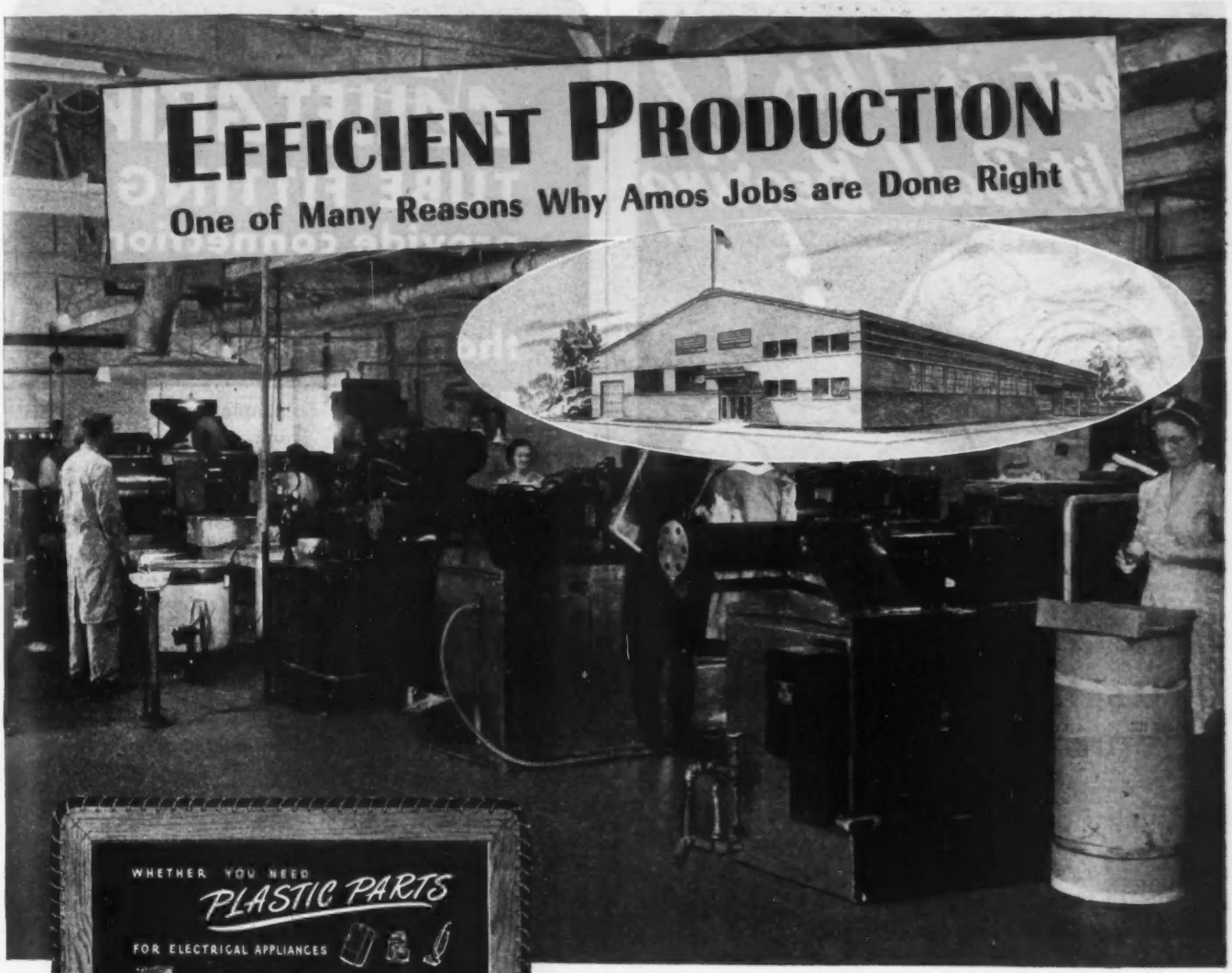
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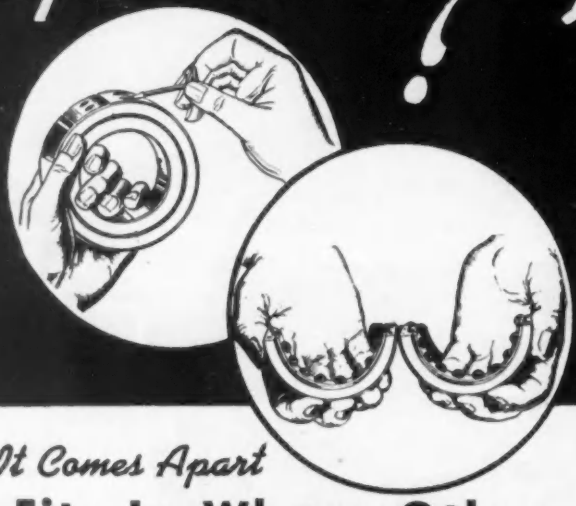
What is This Split Ball Bearing?



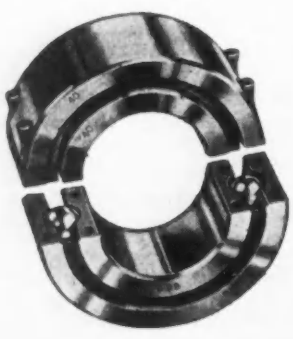
It Comes Apart

Fits In Where Other Bearings Can't Be Used

A split bearing is nothing new. Probably the first sleeve bearings ever used were split bearings. But it took man a few centuries to discover that ball and roller bearings could also be split by a patented process.

These Split bearings, because of their divisible races, are easy to fit on crankshafts, gear clusters, compressors, shaft flanges, accessory drives, connecting rods and other places where solid-race bearings cannot be used.

Split Bearings will deliver the same performance you get from a solid race bearing *plus* the fact that it is divisible. It is manufactured to A.B.E.C. 1 tolerance, a guarantee of efficient, long-life performance — ball or roller, in radial or thrust type.



Split Ball Bearings are held together with special taper-head screws. To divide bearing, unscrew with socket-head wrench. Divisible races permit assembly where solid-race bearings can't be used.

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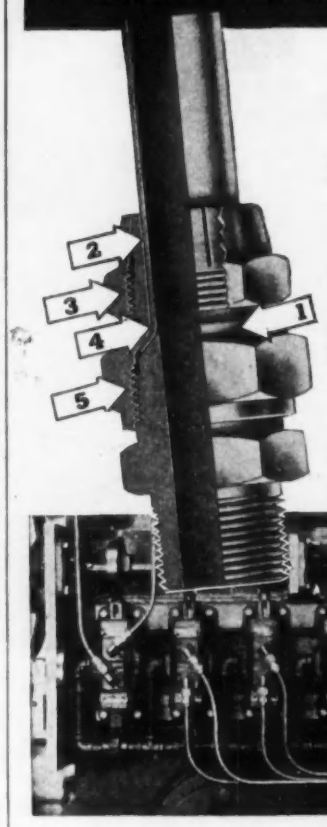
Logan

COLLET GRIP TUBE FITTINGS

provide connections *stronger* than the tubing itself



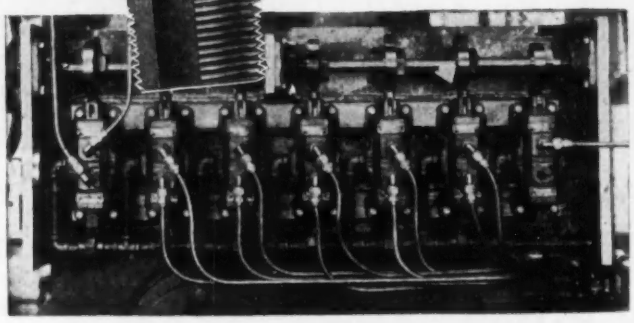
1 Simple design permits installing short tube lengths in cramped quarters.

2 Grip obtained by positive collet grip—not by cutting or digging into tube.

3 Compression nut compensates for variations in O.D. of tubing due to commercial tolerances.

4 Pulling stresses and vibrations are directed away from angle of flare.

5 Long bearing surface of collet nut places heavy load on tube, and supports flare.



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For tight, permanent connections under even the most severe operating conditions, use patented Logan *"Collet Grip"* tube fittings. In this exclusive design, the compression nut presses the slotted collet nut to the tube, providing a grip that cannot loosen under vibration or shock. Connections are actually stronger than the tubing itself.

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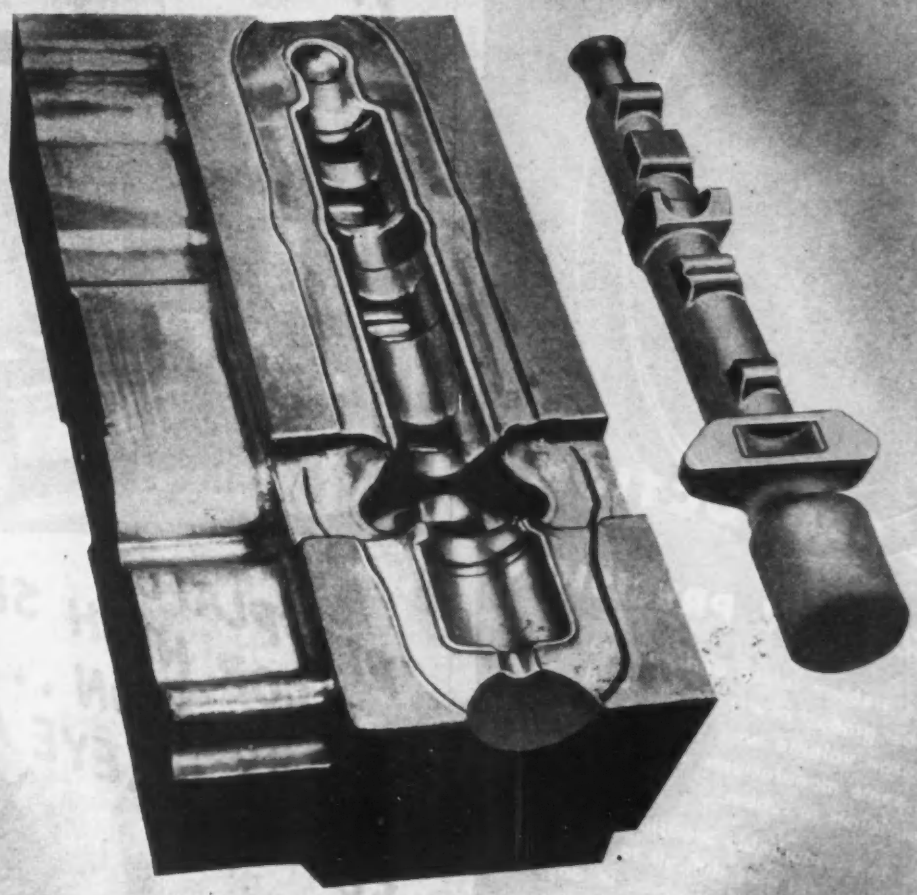

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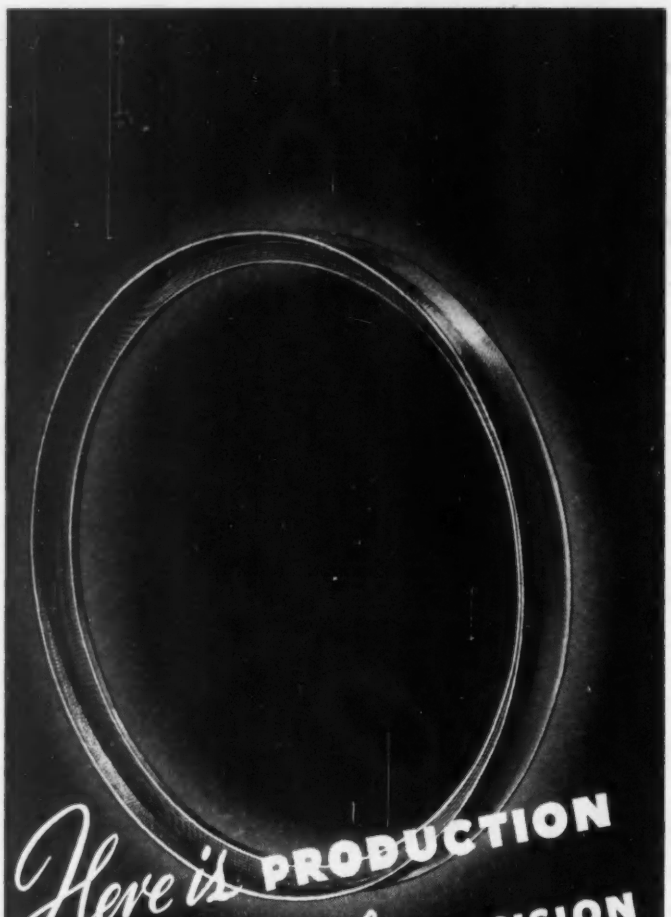

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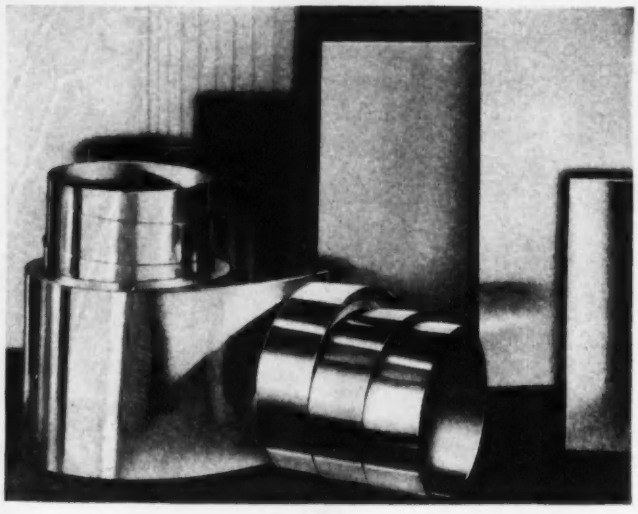

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You'll want to give careful consideration to using the Kodak Linagraph Transfer Process. For detailed information, write Eastman Kodak Company, Rochester 4, N. Y.

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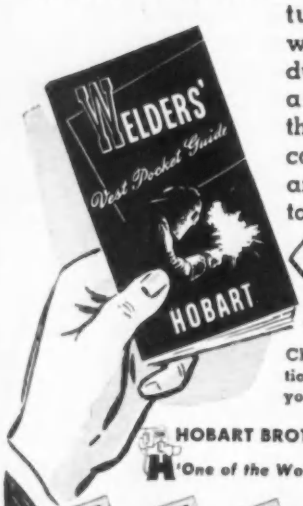

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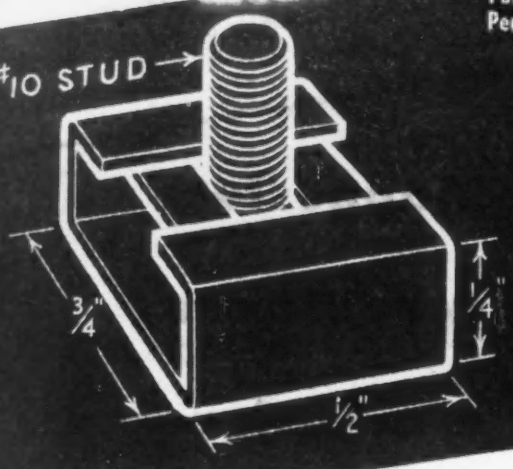

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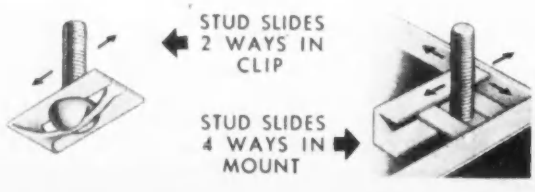
Permits easy alignment of studs with poorly spaced holes. Eliminates the need of a third hand to hold stud from turning.

Available for use with #6, #8, #10 and ¼" screws. Provides for "on the job" change of stud lengths. Sold with or without channels.



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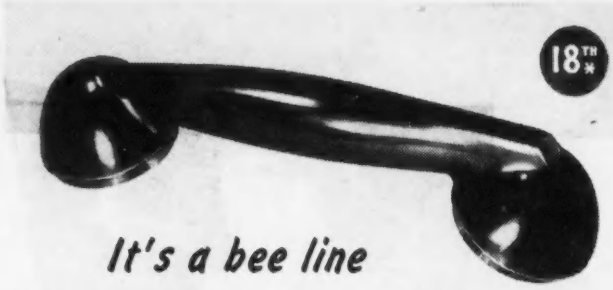


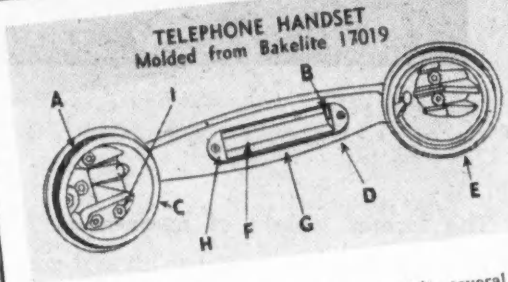
It's a bee line to the battle line with this plastic

COMMUNICATIONS PART

THIS telephone handset, being molded by Aico, is high on the priority list of war production. Efficient communications between command posts and battle lines are a vital necessity to successful warfare. A steady supply of equipment must be kept rolling toward our far-flung battle lines.

The telephone handset molded from Bakelite 17019 was designed for minimum weight and bulk . . . maximum strength. It was engineered for greatest economy and speed of production. It was held rigidly to specifications throughout each step of manufacture.

Aico has had 29 years of experience in precision molding. The elements of successful plastics application—practical design features, precision molds, laboratory-controlled production, finishing short-cuts—are applied to every Aico job to speed up production and lower costs.



BAKELITE 17019 Telephone Handset

MOLDING METHOD
The transfer method was chosen because of its several advantages for this part. It produces less flash where mold joins. Tolerances on inserts can be held more accurately.

MOLDING MATERIAL
Bakelite 17019, a general purpose phenolic, provides the necessary strength and hardness to withstand severe impact and produces a clean, lustrous finish. Since it is free-flowing, it is well adapted to the transfer molding method. It is also especially suitable for molding around inserts. Electronic preheating of the material speeds production and assures uniform curing.

MOLD DESIGN
Aico produced a two cavity semi-automatic mold with extra threaded rings. Threads (A) were particularly difficult because they had to be held to tolerances of plus or minus .002. The long traverse hole (B) extends from the mouthpiece (C) through the handle (D) to the earpiece (E). Walls (F) of cavity (G) are sloped for easier removal from mold. Shoulder (H) holds cover for cavity (G) firmly in place. Note interior construction in mouthpiece (C) and earpiece (E) which holds interior mechanism in place. All 9 threaded metal inserts (I) are flush with molded surfaces.

FINISHING
A wire brushing operation cleans insert surfaces (I). Burrs are removed from cored hole (B). The parting line must also be removed on this particular job.

**This is No. 18 in Aico's series of plastics applications. Send a request on your letterhead for copies of file cards Nos. 1 to 18.*

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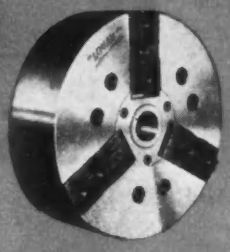
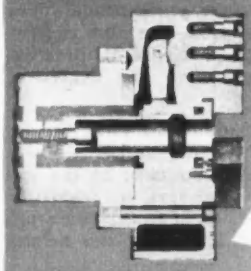
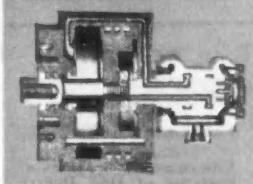


3-jaw universal chuck without false jaws



Simple, sturdy Logan design



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Air-operated chucks, controls and accessories are also available. Logan hydraulic and air-operated chucks come in a wide range of standard sizes and types. Special chucks can also be supplied for unusual chucking applications.

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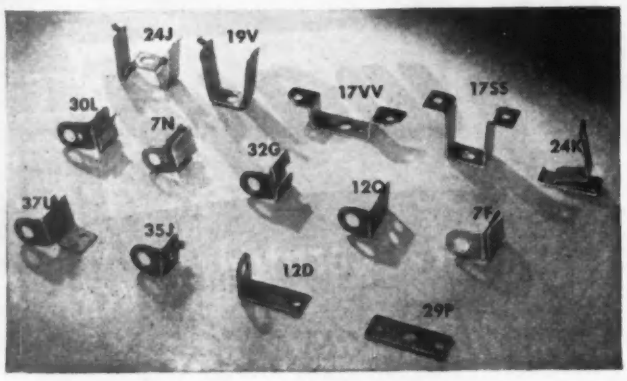

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—how to find the differential equations of motion of a single degree of freedom system
—how to plot a curve of force transmitted versus speed
—how to find the equation of motion of a freely vibrating system
—etc., etc.

CONTENTS

Chapter I
Introduction
Chapter II
Fundamentals
Chapter III
Undamped Vibrations of Systems of One Degree of Freedom
Chapter IV
Damped Vibrations of Systems of One Degree of Freedom
Chapter V
Vibrations of Systems of More than One Degree of Freedom
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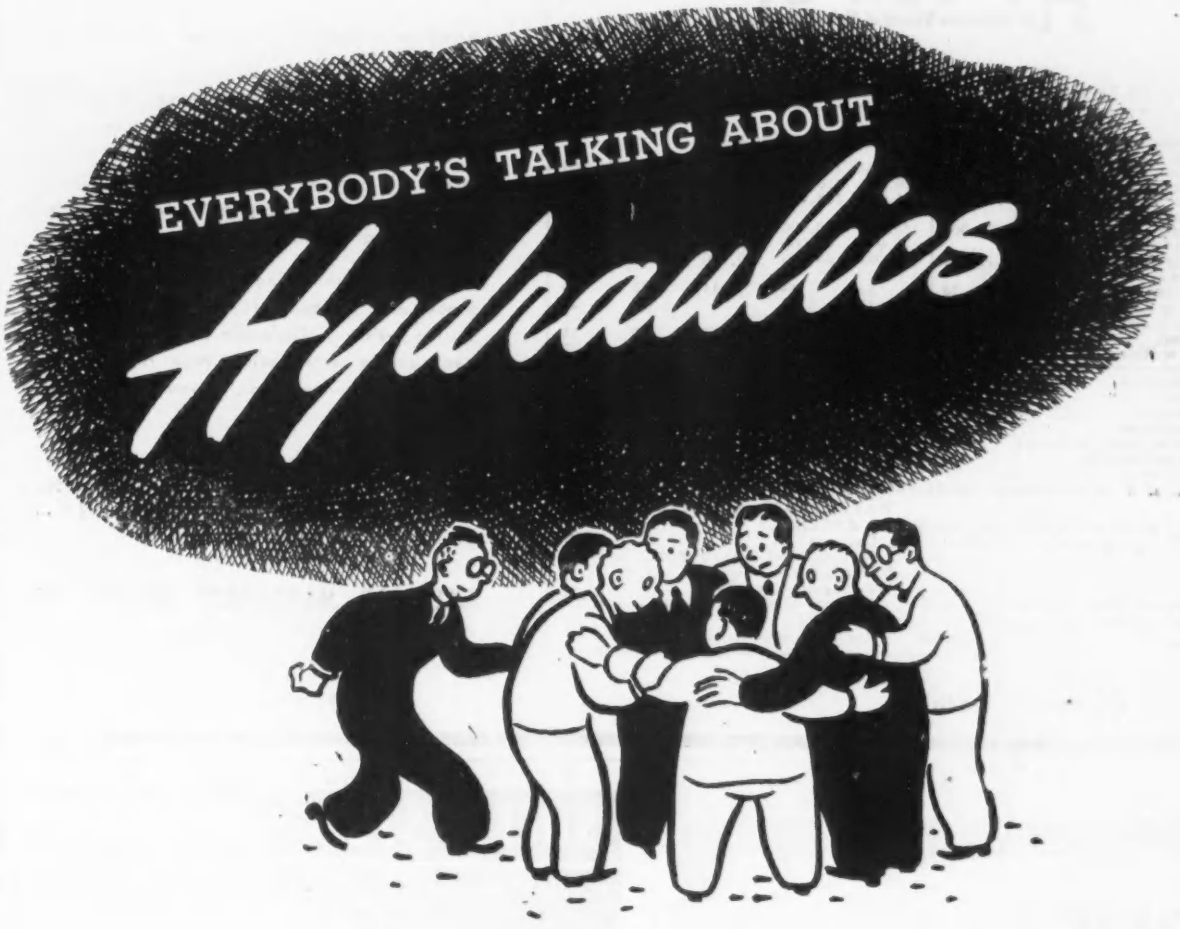

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Sand Cast	125,000	115,000	108,000	100,000	90,000	85,000
Rolled 1" and under	.....	120,000	110,000	105,000	95,000	85,000
Rolled or Forged, over 1"	.....	115,000	108,000	100,000	90,000	85,000
Yield Point (divider method)						
Sand Cast	95,000	75,000	60,000	55,000	45,000	40,000
Rolled 1" and under	.....	75,000	65,000	60,000	50,000	45,000
Rolled or Forged, over 1"	.....	75,000	65,000	60,000	50,000	45,000
Elongation in 2"—%						
Sand Cast	10	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
Reduction in area—%						
Sand Cast	.....	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
COMPRESSION						
Yield Point—						
lbs. per sq. in.	70,000	65,000	58,000	50,000	40,000	35,000
Permanent Set at						
100,000 lbs. per sq. in. (max.)	.015	.020	.030	.050	.080	.125
Brinell hardness, No.	250	240	220	200	175	150

List of U. S. Government Specifications Covering HY-TEN-SL Bronze

ARMY
Forgings, Rolled Rod QQ-B-721 Class B
Castings...QQ-B-726 Class B and C

NAVY
Forgings and Rolled Rod 46B15d Class B
Castings, Aluminum-manganese Bronze 46B29

WATERTOWN and OTHER ARMY ARSENALS
Castings WXS-5
Forgings and Rolled Rod.....WXS-2

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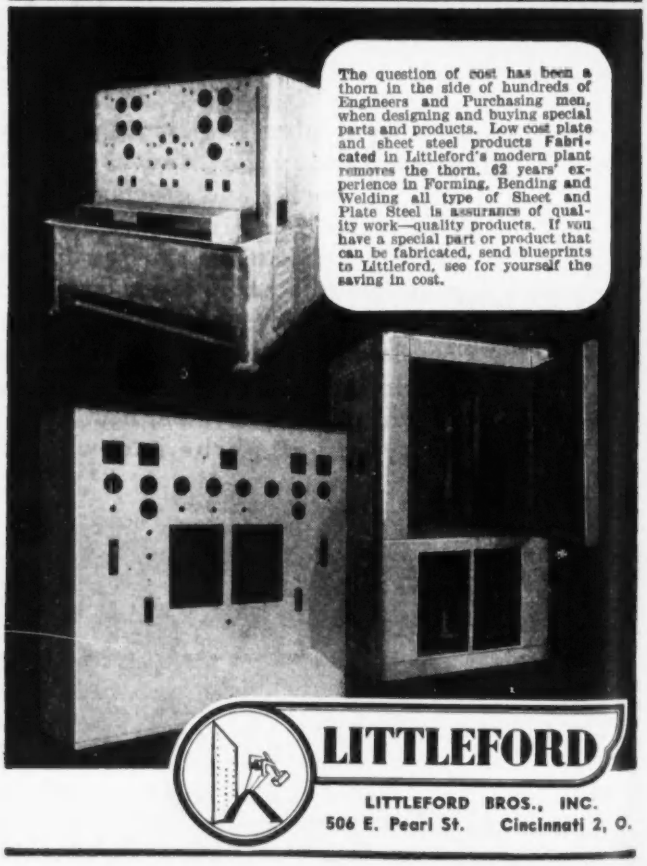

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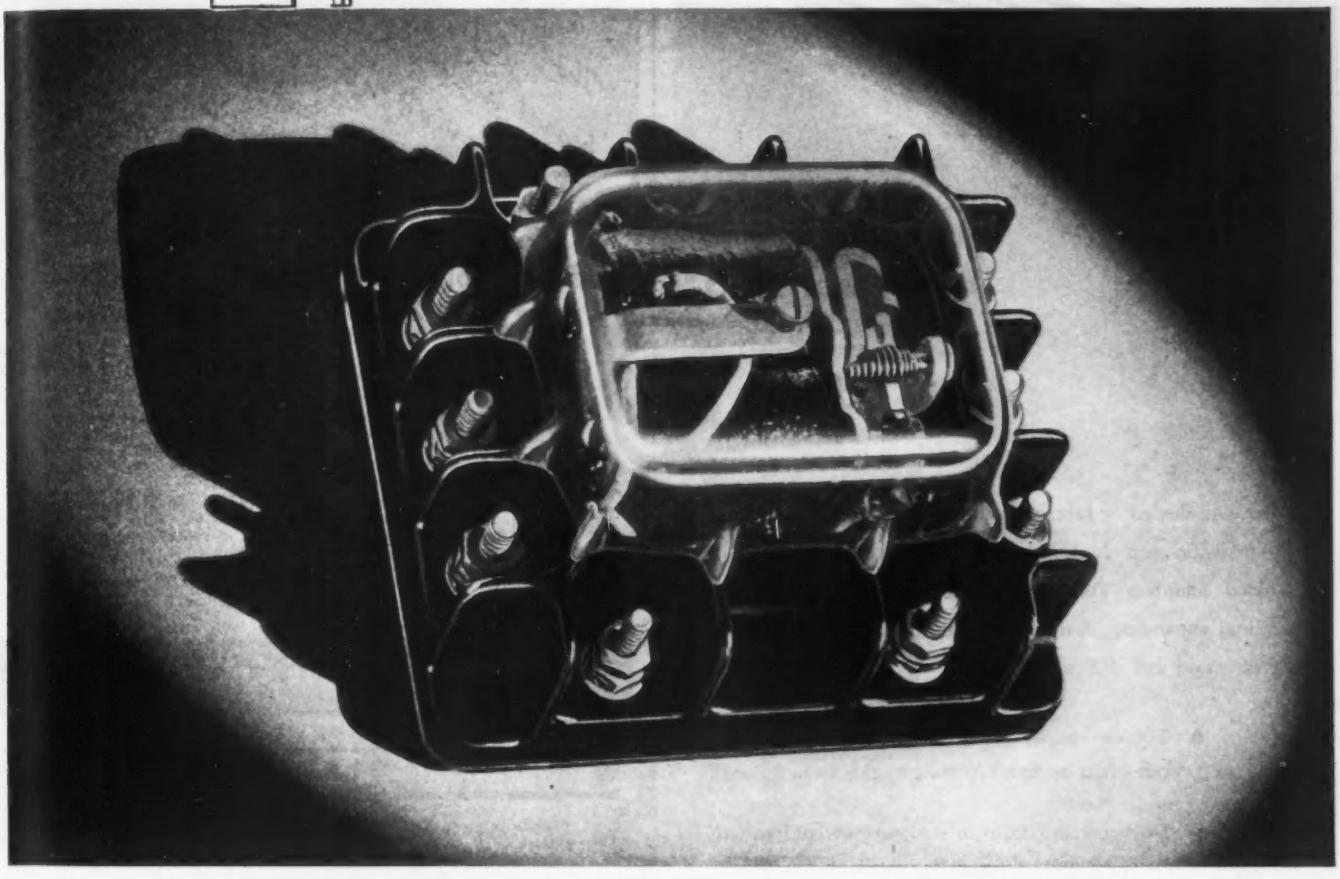

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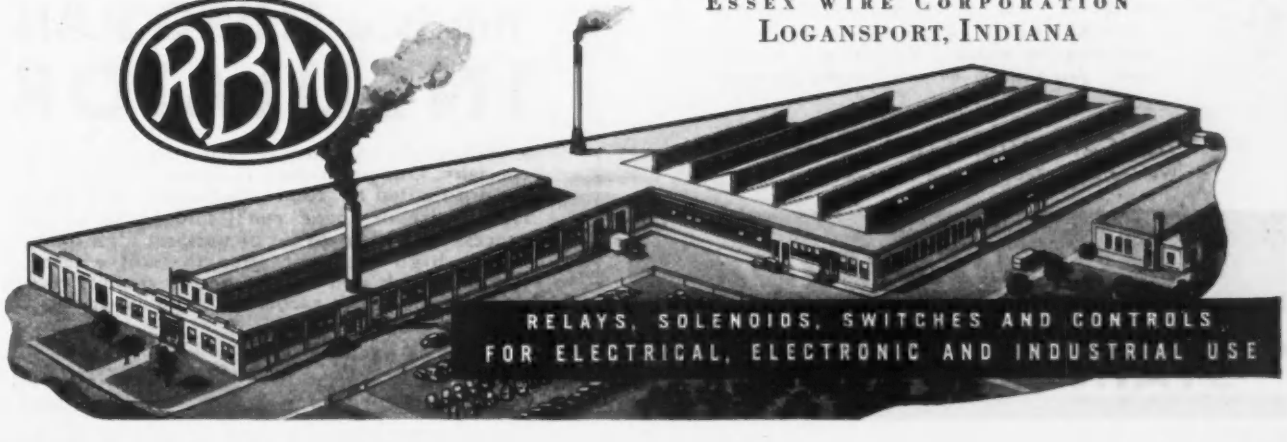

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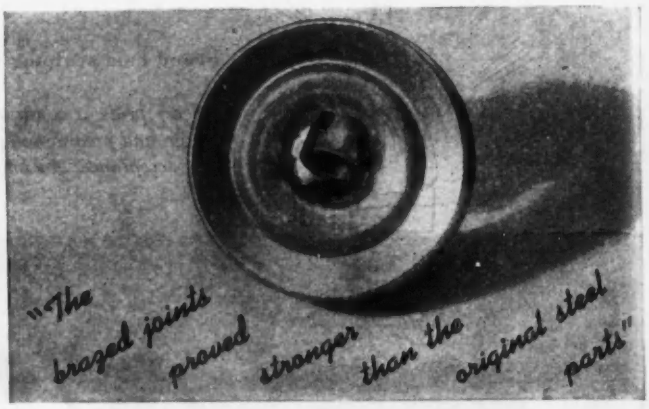

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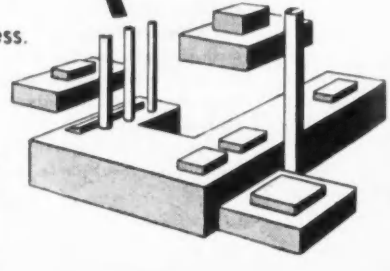

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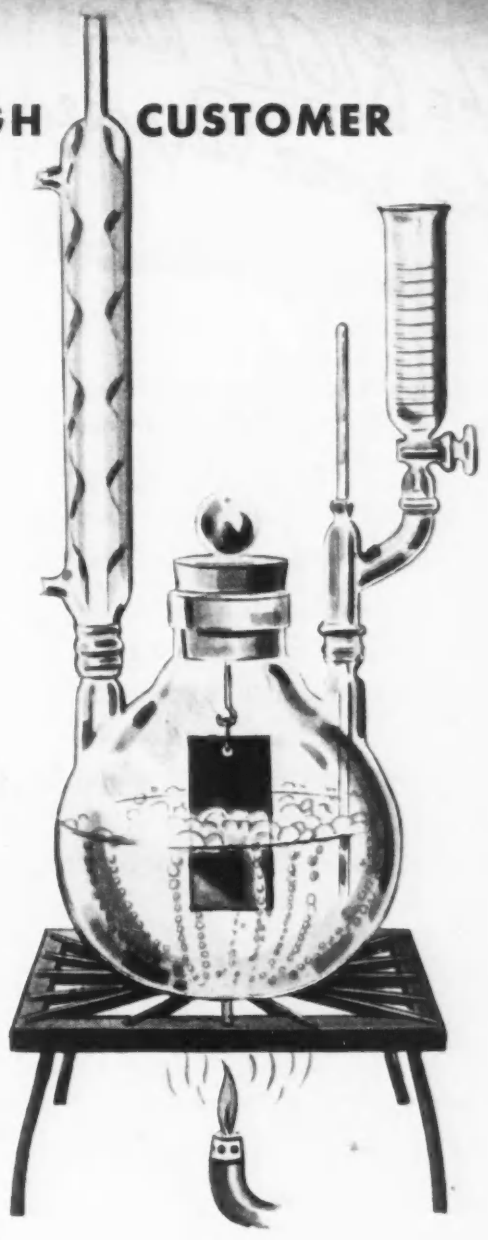

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ONLY ROXALIN MAKES PALADIN

PAGE Stainless Steel WIRE

PAGE STEEL & WIRE

Rx *The RIGHT Wire for your Purpose*

● Can the job be done with wire? Should the wire be round, flat or shaped? What size would do it best? Should it be high carbon, low carbon, or one of the Stainless steels—iron or a non-ferrous metal?

PAGE can answer such questions for you. And, in answering them, **PAGE** may show you how to simplify, economize or speed up your production. For **PAGE** experience includes the use of wire in the making of other products—as well as the manufacture of practically any kind of wire.

. . . and WELDING ELECTRODES

PAGE offers a wide range of electrodes for welding iron, carbon steels and the various analyses of Stainless.

If you use wire in manufacture—if you have a production problem that wire might solve, or if welding is part of your manufacturing process, it will pay you to . . .

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PAGE STEEL AND WIRE DIVISION
AMERICAN CHAIN & CABLE • BRIDGEPORT

TRADE MARK

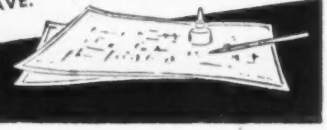
MOLDED PLASTICS
FOR WAR-TIME AND PEACE-TIME PRODUCTS

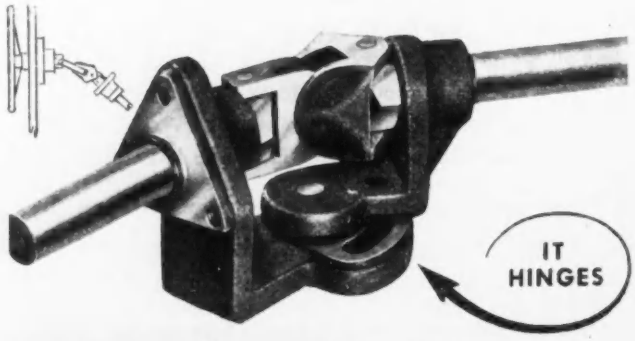
IF you have a plastic problem we invite you to take advantage of our complete facilities—Engineering and Drafting—Machine Shop—Molding dies and Molding—every operation from the drafting board to the finished molded products.

We specialize in Compression and Transfer molding of Thermosetting plastics—Mechanical rubber products to specification—and Laminated materials.

Your inquiry will be treated in strict confidence —and without obligation, of course.

TAYLOR MANUFACTURING CO.
3086 WEST MEINECKE AVE. • MILWAUKEE 10, WIS.





Piezo LINK TYPE—UNIVERSAL JOINT Type H

This new type of universal joint for use in remote controls has three very distinct advantages over other types. (1) It hinges to align with any shaft angle from 0 to 90°. (2) There is a minimum of backlash. (3) The output shaft turns in exact angular rotation with the input shaft. The simplicity of installing saves valuable time in production.

Write for Bulletin 45A for complete data and specifications.

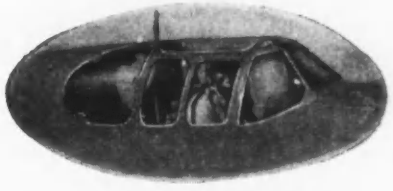
It is recommended for use in air-conditioning equipment, aviation, railroad and marine equipment, petroleum and chemical industries, electronics, machine tools and other machinery.

PIEZOELECTRIC CORPORATION
110 E. 42nd ST., NEW YORK 17, N. Y.

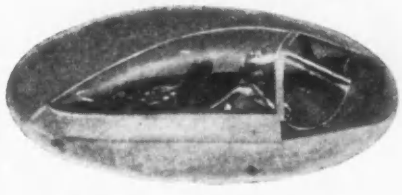
COCKPIT CANOPIES OF "LUCITE"

INCREASE VISIBILITY IN P-51 MUSTANG 75%

OLD WAY



NEW WAY



Advantages: Replaces old-style hood made of eight transparent panels, held together by metal ribs. Eliminates blind spots, permits full vision in all directions in all flying positions. Reduces canopy production time 45% in man-hours. Slides back and forth for easy entrance and exit of pilot. Makes radio equipment accessible instantly.

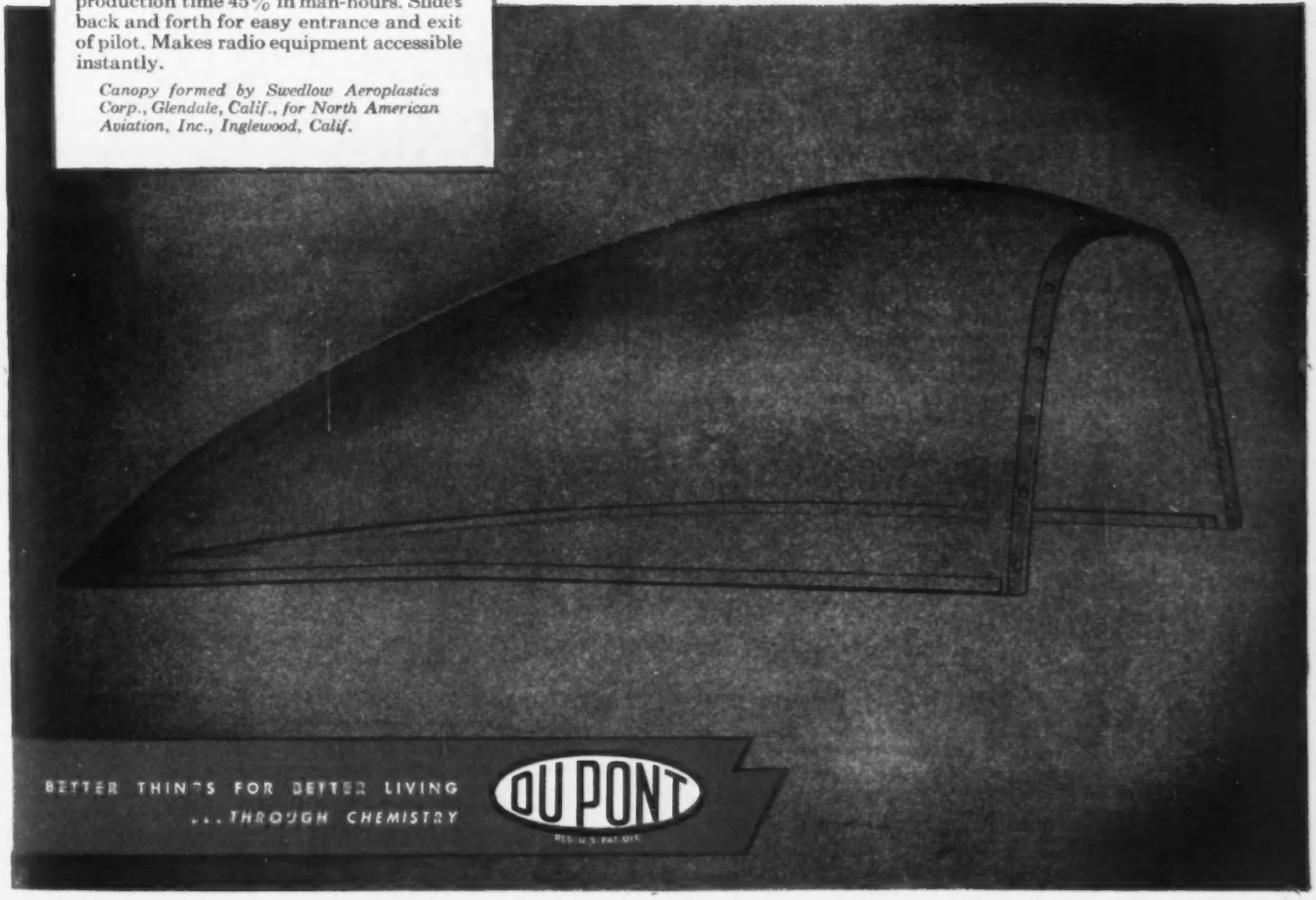
Canopy formed by Swedlow Aeroplastics Corp., Glendale, Calif., for North American Aviation, Inc., Inglewood, Calif.

P-51 Mustang pilots now fly under a protective canopy of transparent Du Pont "Lucite" methyl methacrylate resin. Because of its ability to be heated and formed into streamlined contours, this one-piece enclosure can be shaped by a new vacuum method in less time than was formerly required to produce the old-style canopy. This technique also reduces optical distortion during forming. In addition, the plastic "teardrop" reduces riveting operations and operations on alloy sheet stock as well as eliminating the use of machined parts.

"Lucite" possesses remarkable transparency, light weight, tensile strength and is outstanding among plastics for its weather resistance. WPB-allocated, experimental quantities can be obtained for your test purposes.

Address: E. I. du Pont de Nemours & Co., Inc., Plastics Department, Arlington, N. J., or 5801 South Broadway, Los Angeles 3, Calif. In Canada: Canadian Industries, Ltd., Box 10, Montreal.

DU PONT PLASTICS



The draftsman who jumped to perfection by degrees!

Jim used to start with a 2H—and end in a rage. Each 2H he picked up differed in degree of hardness from the one before. No uniformity—the draftsman's nightmare.

"Look, Jim," we said, "a 2H is *always* the same 2H when it's a Typhonite Eldorado. Try it!"

So Jim discovered uniform, accurate grading in every one of 17 degrees. He also discovered density and clarity of line—the kind of line that assures perfect blueprints.

And the result? Jim's work improved; his enthusiasm went up; his temper went down!... Try Eldorado yourself!

TYPHONITE

ELDORADO

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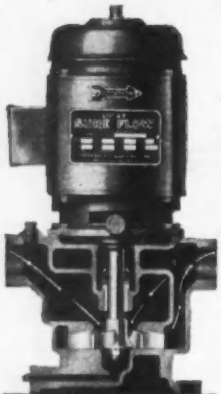
Joseph Dixon Crucible Co.
Jersey City 3, N. J.

DIXON'S TYPHONITE ELDORADO-- 3H

Logan "SURE FLOW" CENTRIFUGAL PUMPS



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Designed Particularly for Pumping COOLANT and CUTTING FLUID

Logan "*Sure Flow*" pumps with integral motor drive provide efficient, dependable service for pumping liquids containing some abrasives, filings and other foreign matter such as found in coolant and cutting oils used on machine tools. The impeller is of the open, unloading type which discharges entrained air or vapor readily. No close clearances or metal-to-metal contacts are exposed to the liquid. Because the pump is self-priming without submerging, it can be installed above or below the liquid level, or remote from the liquid supply.

Logan "*Sure Flow*" centrifugal pumps are available in 3 standard types of mounting—base, bracket or flange. Consult Logan engineers for recommendations on pumps requiring special designs and materials.

BASE MOUNTING | SIDE BRACKET MOUNTING | FLANGE MOUNTING

Logan

FREE Booklet of engineering data and complete specifications on Logan "*Sure Flow*" pumps.

Air and Hydraulic Equipment

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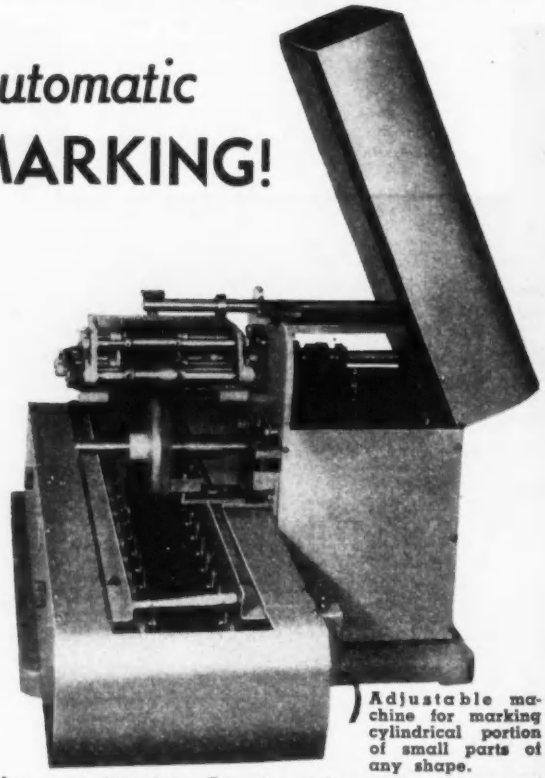

Adjustable machine for marking cylindrical portion of small parts of any shape.

Another new ingenious Superior-made machine to speed production and reduce manpower needs.

Write for "Industrial Marking" Catalog describing marking equipment which utilizes rubber printing dies and inks.

THE SUPERIOR TYPE COMPANY

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VARNISHES

HIGH TEMPERATURE SILICONE INSULATION

Humidity, the primary reason for failure of motors and other electrical equipment, is conquered by DC Silicone Varnishes. Even under extreme conditions of condensation, severe overloads or idleness in moist locations, DC insulated equipment starts and runs at full load.

High temperature silicone insulation was first made possible by DC Varnishes. These new heat stable resins are natural complements to the inorganic spacing materials—mica, Fiberglas and asbestos. Dow Corning Silicone Varnishes provide bonding and filling dielectrics which are highly resistant to heat, moisture, oil and chemicals.

DOW CORNING 993 . . . available in commercial quantities, is a heat curing, high temperature stable silicone varnish for impregnating motor stators, transformer coils and other electrical equipment; for varnishing Fiberglas or asbestos served wire; for varnishing Fiberglas and asbestos electrical insulating cloths, tapes, tying cords and sleeving; for bonding Fiberglas and mica combinations.

DOW CORNING CORPORATION
BOX 592, MIDLAND, MICHIGAN

Dow Corning

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TO SMALL BUSINESSES — the 92 per cent of all business establishments in the country which have been furnishing more than one-third of peace-time factory employment — scientific laboratory services are offered. By becoming a client of a selected commercial laboratory, technical services that are extensively used by both large and small manufacturers become available to anyone who wishes to engage in research and testing for the design and improvement of his product.

Any manufacturer who approaches this laboratory will be offered appropriate services if his problem is within the field in which ETL is competent, or will be referred to another laboratory if greater competence in this field exists elsewhere.

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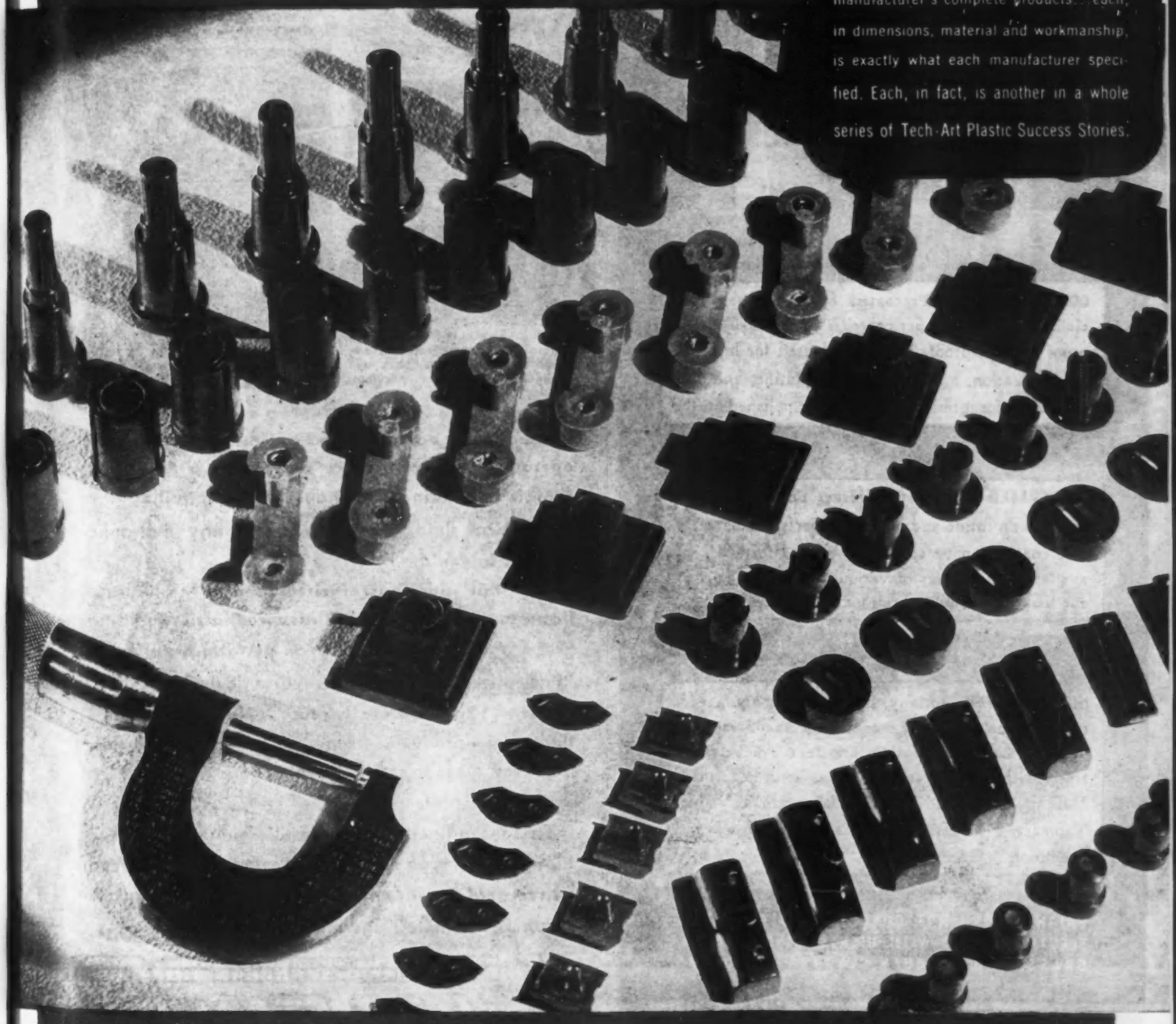
▾ NEW YORK 21, NEW YORK ▾

Minute Ideas . . . Molded in PLASTICS

Whether your product is one requiring plastic parts of minute dimensions or one large enough to require giant molds and maximum molding pressures, Tech-Art will produce them for you economically and with those precision methods characteristic of Tech-Art's mechanical ingenuity and high engineering standards. For back of its every plastic achievement is the sound product engineering of Tech-Art's engineers . . . the practical knowledge of Tech-Art's skilled mold builders and craftsmen. This knowledge and skill plus Tech-Art's extensive production facilities has been responsible for its many plastic success stories.

A Series of Plastic Success Stories

In this illustration is shown a variety of miniature molded plastic parts which various industries brought to Tech-Art to mold. Each is a precision part, some of them containing inserts with threads as fine as 1-72. Each is a precision part of some manufacturer's complete products . . . each, in dimensions, material and workmanship, is exactly what each manufacturer specified. Each, in fact, is another in a whole series of Tech-Art Plastic Success Stories.



TECH-ART
PLASTICS COMPANY

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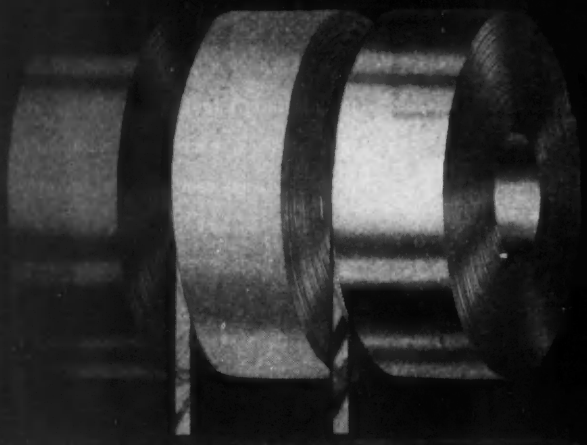
SUCCESSORS TO BOONTON RUBBER MANUFACTURING COMPANY
PIONEER PLASTIC MOLDERS . . . Established 1891

PRECOATED COLD ROLLED

Thomas Strip

the THRIFT METAL of STRIP STEEL



COPPER COATED — Precoated by a Thomas Specialized process, copper coated Thomastrip is crackproof and peelproof. It is widely used for brazing, die lubrication, a base for further plating, and also final finish for interior use . . dull or polished finish.

ZINC COATED — Precoated finishes provide uniform coatings on inside and outside of parts. Thomastrip zinc coated can be spun, drawn, and formed . . . available in coatings of various weights — coils or cut lengths — dull or bright finish.

NICKEL COATED — Many progressive manufacturers use Thomastrip nickel coated for final finish also as a base for further plating. The ductile nickel flows freely with the steel as it is drawn, bent, or formed. Dull, polished, and buffed finishes are available. Thomastrip nickel coated is also crackproof and peelproof.

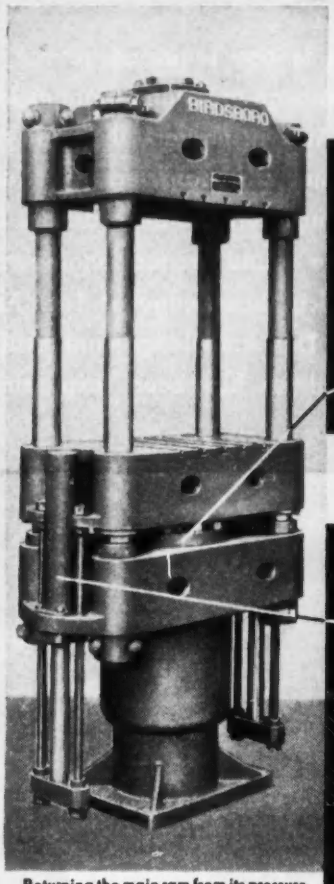
BRIGHT FINISH NOT COATED, SOLDER COATED, ELECTRO-COATED WITH NICKEL, ZINC, COPPER, BRASS, AND LACQUER COATED—IN COLORS

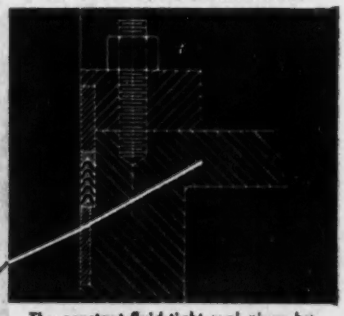
THE THOMAS STEEL CO., WARREN, O.

SPECIALIZED PRODUCERS OF COLD ROLLED STRIP STEEL

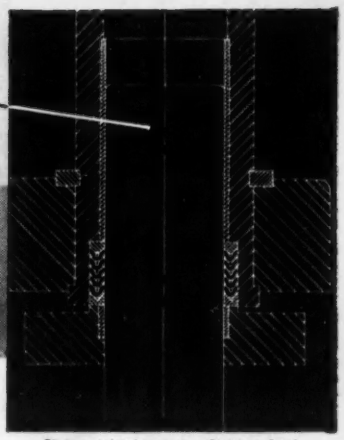
3000 LBS. PRESSURE..

SEALED IN BY LINEAR "PAR" PACKINGS





The constant fluid-tight seal given by Linear "Par" packings aids this 18" diameter ram to operate at top efficiency.



Returning the main ram from its pressure position in a minimum of time is accomplished by these 3½" pull back rams packed with Linear "Par" packings.

Photo and sketches courtesy Birdsboro Steel Foundry and Machine Co. Birdsboro, Pa.

Hydraulically operated mechanisms are enabled to operate at peak efficiency only when a fluid-tight seal is maintained. Without fully controlling the hydraulical fluid, the efficiency of any hydraulic press is lowered.

Linear "Par" packings efficiently *seal in* the hydraulic pressure actuating this Birdsboro Plastic Moulding press, and help it deliver peak performance. Linear "Par" packings confine the hydraulic fluid . . . oil or water . . . in the press without leakage. This fluid-tight seal—produced from zero to peak pressure—helps the press to attain the rated capacity for which it was designed.

Design engineers for hydraulic equipment of the most modern type specify "Par" packings to effect a perfect seal. Linear engineers offer you their consultation . . . sample rings mailed on request.

LINEAR

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An Aluminum Alloy—Non-Heat Treated. The perfected metal that surpasses all others for a wide variety of machining operations. Non-corrosive—Easy on machine tools—Holds threads without stripping. Its light weight reduces table and machine loads and increases tooling accuracy. 5 years of proven superiority in hundreds of plants. OH 38 is an exclusive Hedstrom product.

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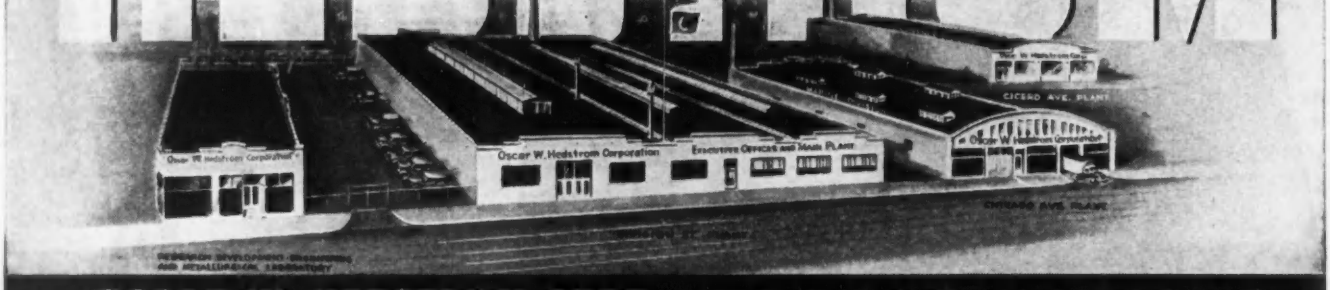

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Work in connection with the manufacture of a wide variety of new and advanced types of communications equipment and special electronic products.

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Applicants must comply with WMC regulations

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AN AUTOMATICALLY CONTROLLED GAS, GASOLINE or DIESEL ENGINE

Is the Best Answer To Your Power Problem

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SEARCHLIGHT SECTION

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MECHANICAL ENGINEER — Midwest steel company has opening for graduate mechanical engineer. Applicant should have experience in plant layout, machine design and constructions. Give complete record of experience, qualifications, and draft status. Statement of availability required. P-848, Product Engineering, 520 N. Michigan Ave., Chicago 11, Ill.

ELECTRIC SPOT welder experienced in welding aluminum on a Sciaky machine; give complete details. Benson Manufacturing Company—18th & Agnes Avenue, Kansas City, Missouri.

HYDRAULIC ENGINEER — unusual opportunity for capable man thoroughly versed in hydro-electric design and installations. P-875, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

MECHANICAL OR Electrical Engineer. Experienced in design and research work of air conditioning and refrigeration equipment for a large and well established company in the eastern states. Give age, education and previous experience. P-896, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

DESIGN ENGINEER. Experienced in design of refrigeration compressors and condensing units for a large and well established company in the eastern states. Give age, education and previous experience. P-897, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

WANTED: DESIGNER—Experienced designer with thorough knowledge of modern machine tool design practice. Excellent position for top flight man. For a personal interview please write giving full details including salary expected. Located in western New York. All applicants subject to labor stabilization rules. P-876, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

DESIGN & DEVELOPMENT Engineer. An old and well established firm, located in Western New York State and engaged in the manufacture of heavy steel and alloy process equipment, desires to interview men having five years or more of designing experience. This is an excellent opportunity and a permanent post-war position. Salaries will be commensurate with ability and experience. Replies held strictly confidential. P-879, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

DRAFTSMAN - MECHANICAL — Opportunity for permanent position with established firm of engineers and manufacturers tractor cranes and hoisting machinery. Location Brooklyn, N. Y. Please reply fully covering experience and salary expected. P-898, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

INDUSTRIAL ENGINEER—Time study, methods engineering, etc. with press and machine shop experience. Plant located in Metropolitan New York District. Products vital now and after the war with no re-conversion problem. P-901, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

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SALARIED POSITIONS — The advertising service of 35 years' recognized standing negotiates for high salaried supervisory technical and executive positions. Procedure will be individualized to your personal requirements and will not conflict with Manpower Commission's. Retaining fee protected by refund provision. Identity covered and present position protected. Send for details. R. W. Bixby, Inc., 268 Delward Bldg., Buffalo 2, N. Y.

POSITIONS WANTED

AVAILABLE — EXECUTIVE Manager, thoroughly experienced in setting up and directing organizations for Engineering, production, sales and office in metal working industries with speed and economy. Well versed on government regulations. Capability has been successfully proven. PW-902, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

PRODUCT DESIGNER and mechanical engineers desire contracts with reliable firms to develop post-war products. Ten years average experience on design and development or precision mechanical, electrical, and optical devices. PW-899, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

BUSINESS OPPORTUNITY

BRICK LAYING Machine—20 bricks per minute lay walls of average house in three days —air operated—cost same as light truck—works from steel scaffold—available for post-war development. BO-903, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

SALESMAN AVAILABLE

MECHANICAL AND Sales engineer with several years experience as manufacturers representative desires connection with reputable manufacturer as Washington representative. Has specialized in the introduction of new products to government and industry. Known as a good engineer and go-getter. SA-900, Product Engineering, 330 W. 42nd St., New York 18, N. Y.

REPRESENTATIVE AVAILABLE

MANUFACTURERS REPRESENTATIVE. Graduate electrical engineer, 22 years experience, now chief engineer small motor manufacturing, desires to represent two or three manufacturers of electrical and mechanical equipment in some good midwestern territory. RA-904, Product Engineering, 520 N. Michigan Ave., Chicago 11, Ill.

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For Post-war manufacturing. Organization with complete Engineering Department, tool making, and manufacturing facilities. Modern plant, in position to develop, manufacture, advertise and sell. Royalty basis or any other satisfactory arrangement.

BO-885, Product Engineering
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We Offer Engineering Drafting Service

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NATIONAL MACHINE PRODUCTS
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In Building and Construction Field

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BO-888, Product Engineering
330 W. 42nd St., New York 18, N. Y.

PRODUCTS WANTED

★

One of our clients with a broad background in heavy good manufacturing is interested in acquiring patentable products or those already patented in the transportation, building and communication industries. Their metal working plant on the Eastern seaboard, is large and thoroughly staffed with design and production engineers. In addition, a special merchandising division for distribution and advertising is available to set up full scale promotions. Inquiries are invited from inventors, product designers, and others who are interested in seeing their ideas transformed into practical products for industry.

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BO-892, Product Engineering
520 North Michigan Ave., Chicago 11, Ill.

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Experienced on design of presses, press feeds, hoppers, etc.

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Experienced on Jigs & Fixtures or Plastic Mold Design.

Above positions in *Powder Metallurgy* field with old established company in New Jersey. Excellent Post War future. Write full details in first letter including salary desired.

P-905, Product Engineering
330 West 42nd St., New York 18, N. Y.

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Industrial Corporation desires additional personnel in Research Laboratory. We have openings for experienced persons and junior positions for College graduates without experience. Please give full details of experience and salary desired.

Plant located in Eastern Pennsylvania now 100% on war work, but post-war work and position assured.

Address P-883, Product Engineering
330 W. 42nd St., New York 18, N. Y.

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Well known manufacturer interested in establishing additional line of aluminum stainless steel products. Man must be experienced and capable of developing, designing, and putting into manufacture such items. In reply cover carefully experience, also age and salary expected.

P-889, Product Engineering
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Leading paper manufacturer and converter located in New York City has positions with excellent futures for layout men with approximately 10 years experience with automatic machinery. Several detailers with 3 to 5 years experience are also needed. Present staff is small and must be considerably enlarged for now and post-war. Write fully as to education, experience and salary requirements. Product assigned highest essentiality rating by Government authorities. If your present work will not terminate for several months we would still like to hear from you.

P-891, Product Engineering
330 W. 42nd St., New York 18, N. Y.

WANTED

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For design and development of insulation board mill equipment and allied machinery. Permanent position. Experience in design of paper mill equipment helpful but not required. Location South. State draft status and availability with complete details of experience.

P-844, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

Mechanical Engineers—Electrical Engineers—Experienced Engineers in Armament

Experienced engineers in machine design and sheet metal products. Must be able to do own board work. Have prewar successful background. First class only. Write setting forth full particulars, places worked, projects, etc.

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P-884, Product Engineering
330 W. 42nd St., New York 18, N. Y.

WANTED

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. . . with a good background of experience in tool and die layout for metal stamping, forming and drawing operations; should also be able to help in product design and carry through plans to completion for all necessary tool operations. Please give full details of experience and salary desired. Plant located in Eastern Pennsylvania now 100% on war work, but post-war work and position assured.

Address P-882, Product Engineering
330 W. 42nd St., New York 18, N. Y.

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Mechanical Engineers

Technically trained having experience with manufacturing specifications, methods, quality control and material handling.

If you qualify for these positions, are interested in doing war work now, and in security in the post-war period, write

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Unusual opportunity for responsible position in the field of production research and product design in one of our expanding research divisions. We are also interested in other engineers who wish to follow research as a career.

Battelle Memorial Institute
Columbus 1, Ohio

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Manufacturer needs services of a skilled mechanical engineer. Radio experience is desirable but not imperative. Must have creative mind and ability to supervise others. Our company is growing steadily; its postwar prospects are unlimited. In reply, give all important particulars of education, past experience and salaries earned. Apply

P-895, Product Engineering
330 West 42nd St., New York 18, N. Y.

WANTED

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P-886, Product Engineering
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Ohio Manufacturer with Die-Cast Division, needs Tool or Die Designers to design Die-Cast Dies, Tools, Jigs, and Fixtures. Broad experience with Machine Tools essential. Some Mechanical and Hydraulic Engineering experience advantageous. Living conditions good in small town, or near-by medium sized city. Excellent post-war opportunities. W. M. C. Rules apply.

P-839, Product Engineering

520 North Michigan Ave., Chicago 11, Ill.

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Should have specialty background in single phase motors, having devoted major effort to efficient mass production. Line will have limited size range. Engineering design experience desirable for development of motors for tooling and production. Permanent connection with outstanding Southern California manufacturer entering household appliance field. Send detail of experience and personal qualifications to A. W. A., Box 68 Station E, Los Angeles, California.

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Research & Development Engineering Dept.

Elliott Company

Jeannette, Pa.

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The Collins Radio Company has always been a pioneering organization—an *engineer's* engineering and manufacturing outfit.

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If you feel that you could fit happily and capably into this organization, write us fully. Tell us about your education, experience, age, desired compensation and draft status. W.M.C. regulations, of course, must apply.

Address E. H. Reinschmidt,
Superintendent of Design,
Collins Radio Company,
Cedar Rapids, Iowa.

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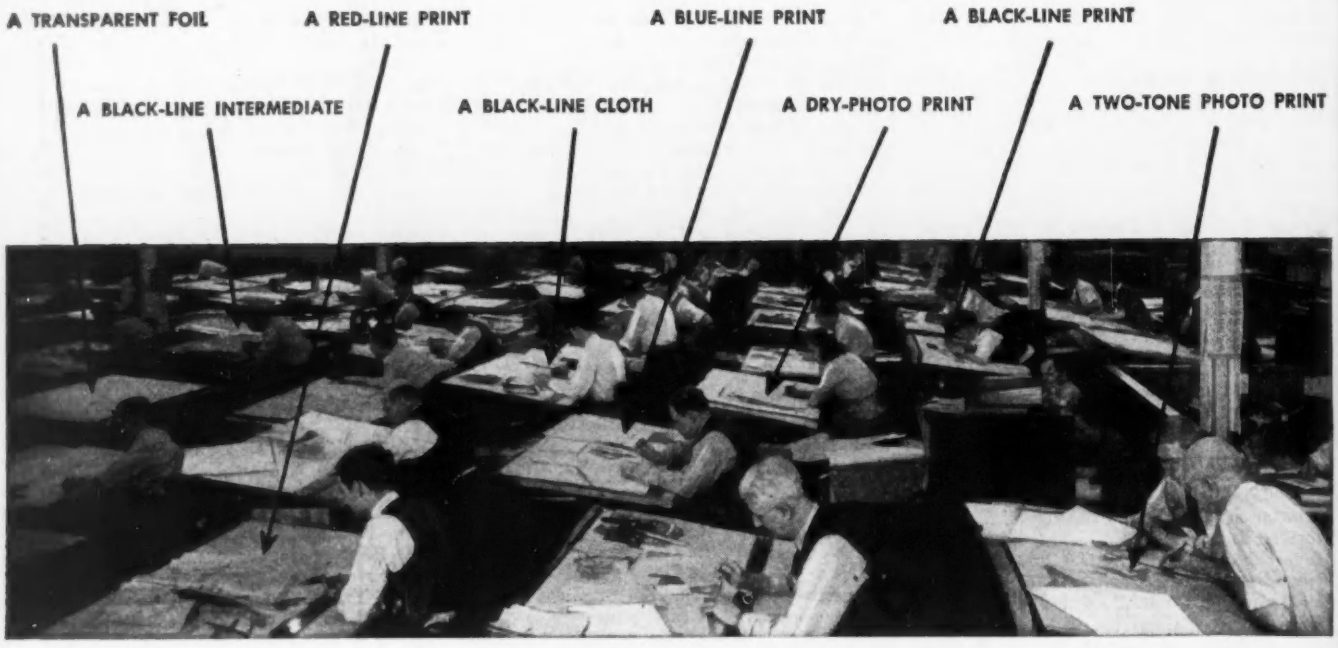

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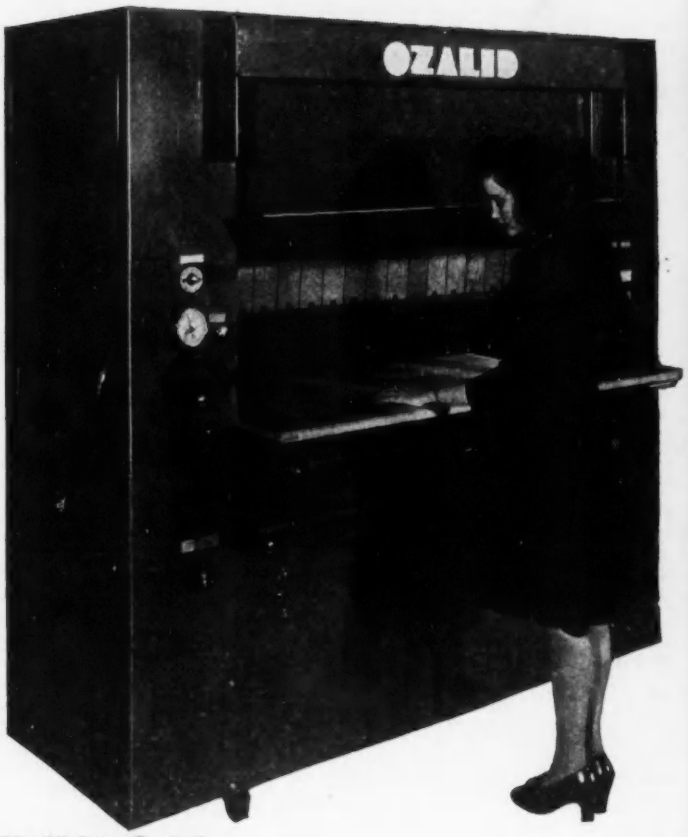

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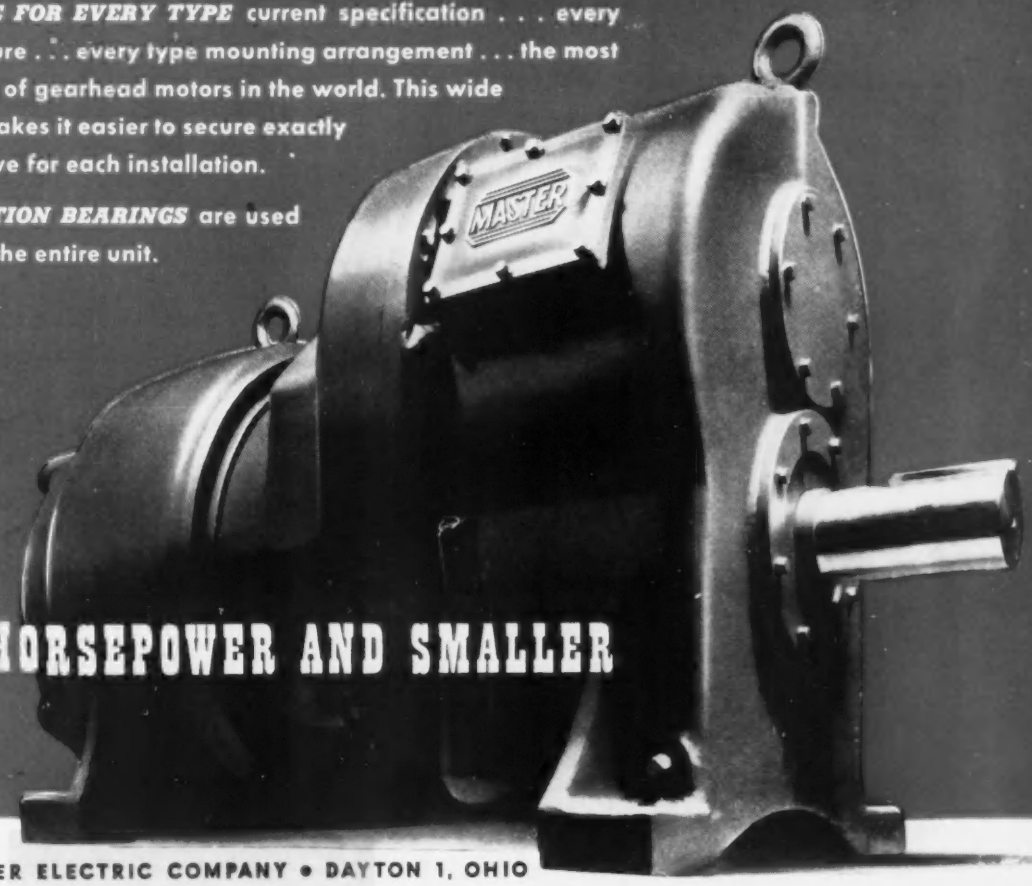

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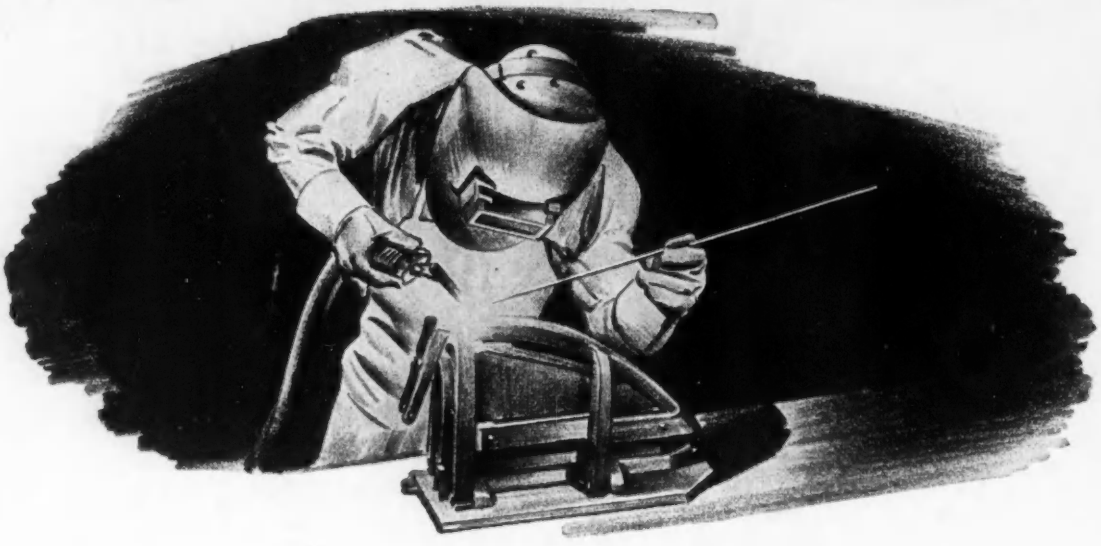

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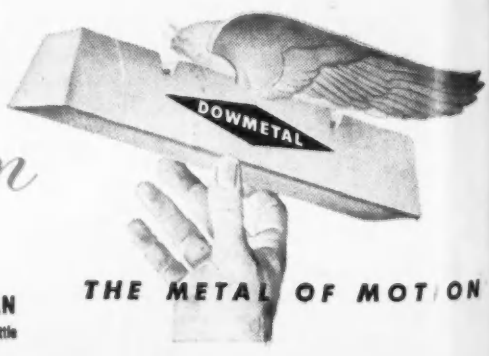

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